ADAPT OR DIE

A possum *takes to the air on outstretched folds of skin to glide from tree to tree. In a million or so years from now, this feature might evolve into flight with wings similar to those of today's birds.*

Mike Price/Survival Anglia

Bruce Coleman Ltd

- NATURAL SELECTION
- CAMOUFLAGE
- MIMICRY

EVERY LIVING THING – including humans – has evolved through natural selection. By this process, plants and animals survive and produce offspring only if they have appropriate adaptations to their environment.

A good example of natural selection at work is the long neck of the giraffe. It is thought that most giraffes once had a much shorter neck, but when the foliage they ate from trees became sparse, only those giraffes that could reach the remaining, higher leaves survived. In turn, they produced off-spring with similarly long necks and the shorter-necked giraffes died out.

A hummingbird *in captivity, feeding. It is well adapted to hovering, and even flying backwards, as it feeds on nectar in flowers – a source of food only insects can usually tap.*

Adaptation

Humans have adaptations to different climatic regions. An example of this adaptation is the colour of skin in different races. Humans evolved in a tropical sun, so they have cells that produce melanin – a dark pigment in skin which helps block the Sun's harmful ultraviolet rays.

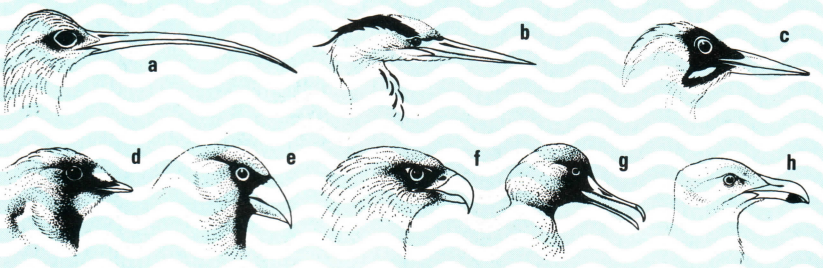
As humans migrated to colder, less-sunny areas, their skin did not require the same level of protection from ultraviolet rays, so they evolved a lighter skin.

Other animals, and also plants,

have evolved over millions of years to survive their particular habitat. In the polar regions, animals like the Arctic fox and Arctic hare evolved the ability to change colour with the seasons to escape predators. In summer, their coats are brown to match the ground, and in winter snow they change to white.

Jungle apes have exceptionally well developed hands, feet, and tail, enabling them to swing from tree to tree. Some species of South American monkey have 'prehensile' tails – tails they can use as an extra limb to hold on to branches.

MAIN TYPES OF BILL



The length and shape of a bird's bill are strong indications of its feeding habits and type of habitat. The long, curved bill of the curlew **(a)** is ideal for probing soft mud. The dagger-like bill of the heron **(b)** is useful for grabbing fish near the surface. The woodpecker's bill **(c)** is strong and chisel-like. The swallow **(d)** has a huge gape to capture insects in flight. The powerful bill of the hawfinch **(e)** cracks nuts. The eagle **(f)** is adapted for tearing flesh. The goosander **(g)** is clearly a fisher. Gulls have an all-purpose bill **(h)**.

Tony & Liz Bomford/Survival Anglia

The aye-aye *– a Malagasy lemur– has long, thin fingers. It uses the especially slender third digit to pick out wood-boring insects from their holes in trees.*

Gerenuks *learn to balance on their hind legs to feed on the only available growth. Their necks and limbs have lengthened over the generations.*

Some tree-dwelling animals, including mammals and reptiles appear to be in the process of evolving the ability to fly. The Paradise tree snake can flatten its body into the shape of a curved ribbon to glide from tree to tree.

The flying lemur of southeastern Asia achieves the same effect with flaps of skin that stretch out like wings at its sides when the lemur spreads its legs. And Wallace's flying frog stretches out its webbed feet to glide from tree to tree.

The desert heat

Many animals have adaptations to living in dry, hot, sandy deserts. Camels, for example, have broad toes which prevent their large bulk sinking into the sand. Gerbils and kangaroos move across the desert in giant leaps, and gerbils have tufts of hair on their feet to insulate them from the hot sand.

Plants that live in dry regions usually have a huge network of roots to reach water deep beneath the ground, as well as systems to store water and reduce its loss. The cactus is particularly good at retaining water. Its swollen stems and fleshy leaves are really store houses for water.

Tricksters

Many species have evolved mimicry as a form of defence against predators. Some harmless animals have evolved certain colours or shapes to mimic dangerous or poisonous species. Predators know that such a species should be avoided and so are fooled into leaving the harmless species alone.

The bee orchid plant has evolved a clever type of mimicry. When a bee tries to mate with the orchid, the bee picks up pollen from the flower and later transfers it to the next flower it mistakes for a bee. So the bee pollinates the orchids without the reward of nectar.

Insects are particularly good at camouflaging themselves for protection against predators. Some look like twigs, others like flowers, seeds, leaves or thorns.

Richard Packwood/Oxford Scientific Films

Just amazing!

COLD COMFORT

ACCORDING TO ONE BRITISH EXPERT, MEN CAN BEST PREVENT HEART DISEASE IF THEY WEAR KILTS AND GO WITHOUT UNDERPANTS.

Paul Raymonde

GOING PLACES

- MOBILE HOMES
- MOTOR CARAVANS
- SAILING BOATS

TODAY MOST PEOPLE HAVE permanent homes, but there are still nomads who travel from place to place, erecting, mooring or parking their mobile homes wherever they choose to stop for a while.

In some regions, nomads use pack animals such as horses or camels to carry their tents. Members of the Bedouin or Tuareg tribes, travelling through the Arabian desert, pitch ridge-pole tents.

Mongolian nomads have two types of tent: a simple one for over-night stops, and a yurt for longer stays. This has a lattice frame draped with thick felt and is divided into three rooms: one for sleeping (at the back of the tent) and separate day-areas for the women and men. A hole in the roof lets out smoke from the fire.

Moving on

Gypsies are the last true nomads living in Europe today, where their numbers are estimated to be between four and five million. Like holiday nomads (that is, tourists), those Gypsies who still travel live in either a motor caravan or one drawn by a motor vehicle.

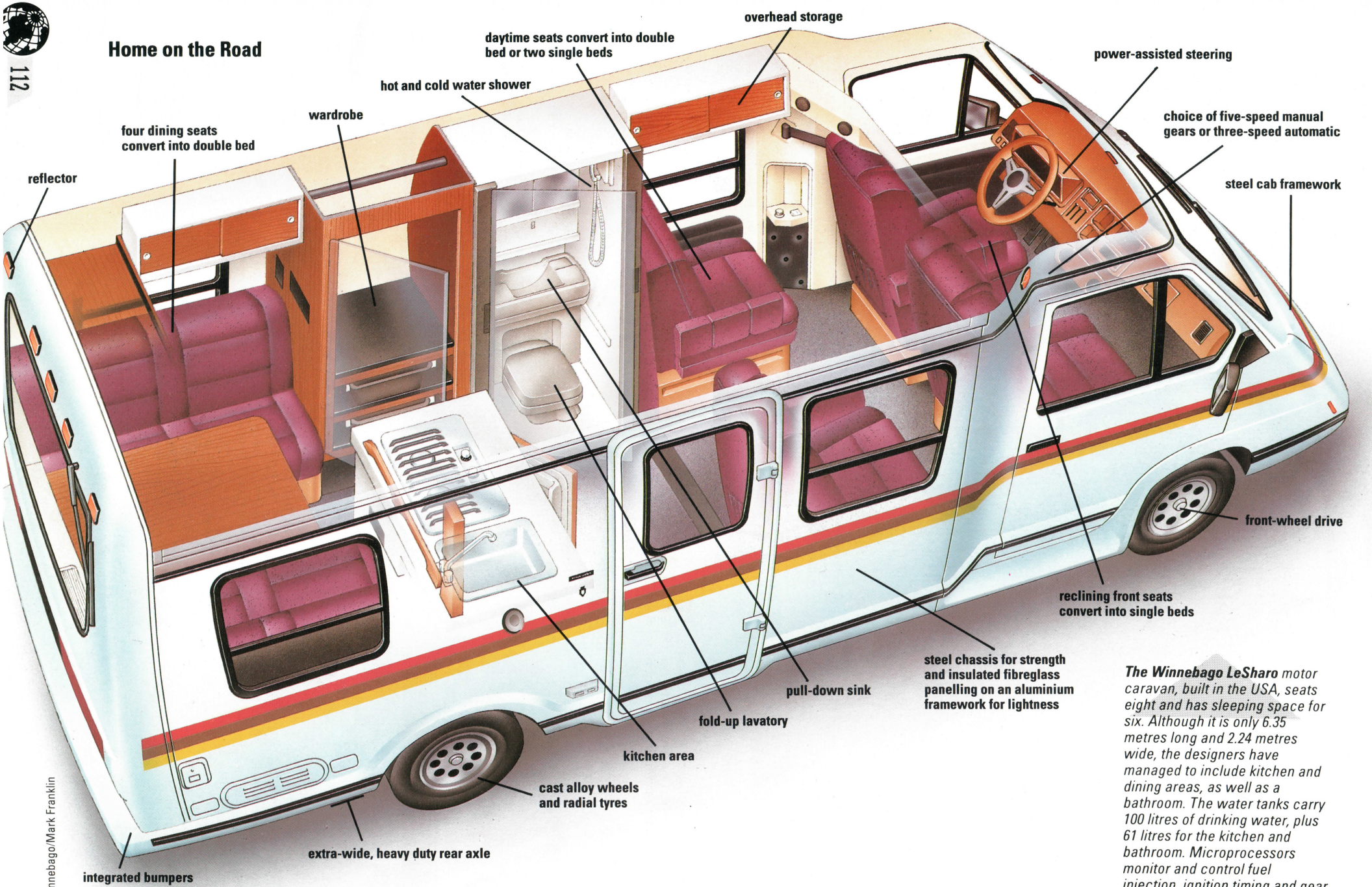
The size of motor caravans varies as much as the fittings inside. A small camper van with living space, engine and controls all situated over four wheels may have one or two sleeping bunks, a simple Calor gas stove, a small fridge and a portable chemical lavatory.

In contrast, there are giant trailers 10 metres long and towed by a powerful motor vehicle. These are designed to cross many hundreds of kilometres of territory, such as the Nullarbor plain of south-west

Never Say Never *is a motor yacht with a cruising speed of 30 knots. The weekly hire rate for a luxury yacht such as Parts VI (dining room inset left) could be as much as $100,000.*

Jon Bannenberg Ltd

Home on the Road



Winnebago/Mark Franklin

The Winnebago LeSharo *motor caravan, built in the USA, seats eight and has sleeping space for six. Although it is only 6.35 metres long and 2.24 metres wide, the designers have managed to include kitchen and dining areas, as well as a bathroom. The water tanks carry 100 litres of drinking water, plus 61 litres for the kitchen and bathroom. Microprocessors monitor and control fuel injection, ignition timing and gear changes.*

ZEFA

Caravan sites *may be laid out just like suburbs, with the addition of shared amenities such as shower blocks, a laundrette and even a swimming pool. This site at Bad Feilnbach, near Munich in southern Germany, has room for 750 caravans, spread over 14 hectares.*

SURVIVING SOLO

The long distance sailor's floating home may be small, but it has to hold everything necessary for a voyage that may last months. Tinned food and drinking water are stowed in the bilges at the bottom of the ship. Clothing and small items of gear, such as tools, are kept in water-tight lockers. The sails and anchor are stowed in the peak of the boat. All items not in lockers must be secured in some way. The chart table is surrounded by a rail. Like the ship's compass, the cooking stove is mounted on a system of pivots and rings (called a gimbal) that keeps it level.

Australia, without stopping for supplies. There is sleeping space for ten, plus a kitchen, a recreation area, hot water, flush lavatories and a shower unit.

Modern campers may still use tents. Elaborate affairs usually made of cotton fabric and lightweight metal tubing, these frame tents vary from three-sided awnings, which rest against the car or van, to fully enclosed tents with several rooms.

Boat dwellers

Many people who have mobile homes opt to travel by water rather than on land – they live on a boat. A wide variety of flat-bottomed craft is moored along rivers and canals, including the narrowboats once used to carry anything from coal to clay up and down the waterways. Boatmen lived on the barges with their families. Today many have been converted into homes by people who have jobs on the land.

The houseboat in its simplest form can be moved only by towing, but most have inboard or outboard motors at the stern. Houseboats 12 metres long can travel at 50 km an hour in coastal waters. However, with their shallow draft, high sides and large windows, houseboats are designed for maximum living area – and minimum sea worthiness. At a permanent mooring, a houseboat can often be plugged into mains electricity and enjoy such services as regular rubbish collections.

On Dal Lake in Srinagar in the Kashmir Valley of Northern India there are over 1300 elaborately decorated houseboats, which are rented out by their owners to tourists. It was the British who first lived on the lake, because they were forbidden to build on the land.

The Hutchison Library

Junks *cram the harbour of Cheung Chau island, part of the Hong Kong New Territories. Once a base for pirates, Cheung Chau's major industry is now fishing. The fishermen live with their families on the junks. A further 30,000 Hong Kong citizens are boat dwellers, travelling to the shore and back by water-taxi.*

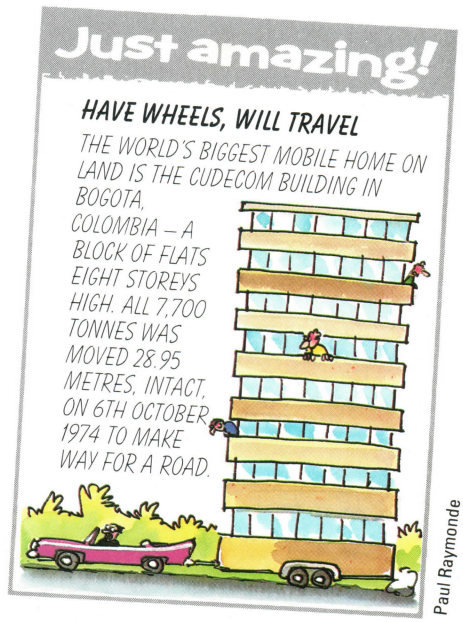
Sea-cruising

Yachts (with or without engines) and cabin cruisers are both equipped so that the crew can live in them for months at a time. Cabin cruisers developed when rowing or sailing vessels were adapted to take an engine, and covered with a roof to create living quarters.

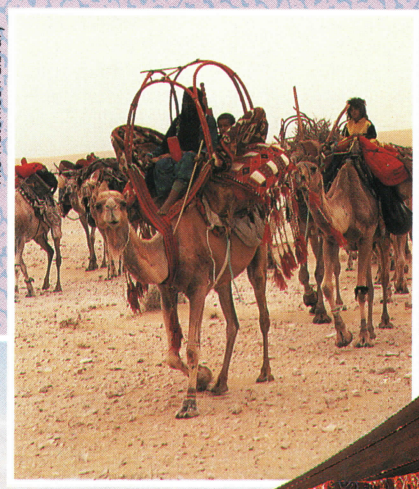
At the top end of the market are the great luxury yachts and cruisers, owned by millionaires and royalty. A famous example is the Royal Yacht *Britannia*, one of Queen Elizabeth II's homes. The *Britannia* is 125.6 metres long – half the length of the liner the *QE2* – 16.7 metres wide, and, running on diesel engines, has a cruising speed of 21 knots. The ship's crew numbers 276, including a 26 piece Royal Marine band. The Queen's dining room can seat 56 guests and doubles as a cinema. The ship costs about £10,000 a day to run. There is even a garage for the royal Rolls Royce.

Liba Taylor/The Hutchison Library

Gypsy caravans *of the traditional type, made of wood and horse-drawn, are nowadays rarely seen on the road. Most travelling Gypsies prefer modern caravans towed by motor vehicles.*



Paul Raymonde



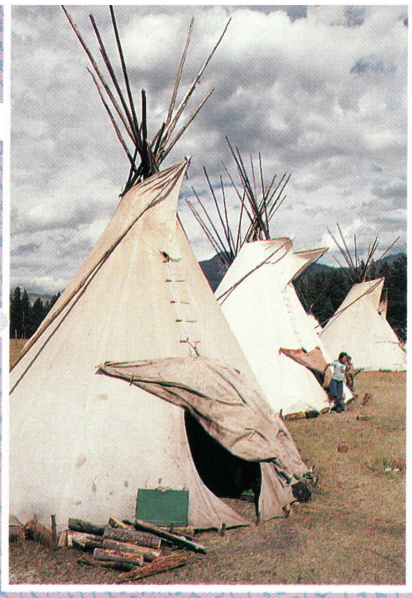
The Hutchison Library

Bedouins *transport dismantled tents to the next camping place in the Arabian desert on the backs of camels.*

Nomadic Berbers *in the Sahara pitch tents woven from sheep's wool and goat's hair.*

Spectrum Colour Library

Tepees *nowadays provide homes for only a few native Americans. Animal skins are stitched together and stretched over a cone-shaped wooden frame. Smoke from a fire inside escapes through the top.*



Halle Flygare Photos/Bruce Coleman Ltd

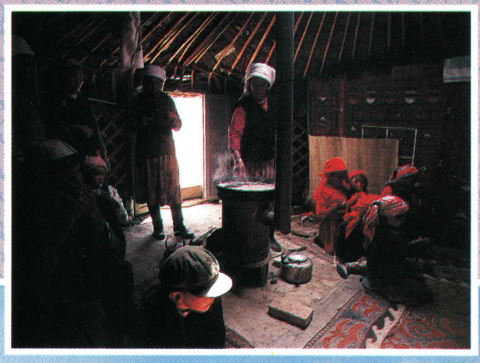
Tree houses *are built by the Koiari people of Papua New Guinea, as look-out points, to watch for attacks from neighbouring tribes.*

ZEFA

ZEFA

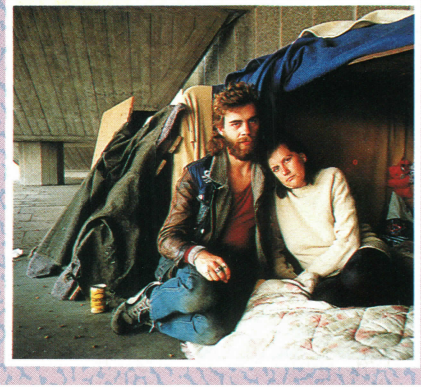
An igloo *is the traditional Eskimo winter home. Although made from blocks of ice, the inside can be surprisingly hot, warmed by a burner fed with seal oil.*

A yurt *is a wooden frame covered with layers of woollen felt. It is a long-stay tent used by nomads in the colder parts of Asia, such as Mongolia.*



John Cleare/Mountain Camera

Mud *is a popular building material wherever trees are scarce. This mud and grass cabin has been built by Eskimos in the mountains of Alaska.*



ZEFA

'Cardboard City'*, in London, Great Britain, is inhabited by homeless people who build shelters out of cardboard boxes. This distressing social problem exists in many of the world's cities.*

Spectrum Colour Library

Sturrock/Network

Detergent bubbles *tear apart globules of animal fat below the warm water surface. Detergent action will eventually dissolve the solid fats.*

POWER CLEANING

Paul Brierley

MODERN KNOWLEDGE OF germs and bacteria has led us to understand that cleanliness is essential to health. Much scientific thought has gone into developing domestic cleaning appliances and these are constantly being improved.

Electric showers operate independently of home heating systems to ensure constant hot water for washing. Tumble driers are made to turn off when clothes are dry. Vacuum cleaners are fitted with filters to prevent small dust particles (and some dust mites) being blown back into the room being cleaned.

Invisible guests

Dust mites are microscopic creatives that live in carpets and mattresses and nowhere else. They feed on minute flakes of human skin, which people shed at a rate of tens of thousands of flakes per minute. Mites are sucked up by the vacuum cleaner, but some are blown straight through the dust filter to land back on the carpet, there to wait for the next meal of skin cells shed as you move around the room!

The vacuum cleaner was invented in 1901 and has changed very little since then. It could be called a mechanical broom — a broom not only sweeps dust along in front of it, but also creates a partial vacuum behind each bristle which sucks dirt along after it.

Machines help with personal hygiene, too. Dirty clothes are loaded into a fully automatic, front-loading washing-machine, a washing programme is selected from the control panel and the machine can be left to do the rest — unsupervised.

Sound method

Ways have been found to make these machines less wasteful of water, detergent and electricity. New models have delay timers built in so that washing can be done at night, when electricity is cheaper. Both washing-machines and dishwashers use many litres of water, often heated to high temperatures, and they require energy to turn the drum or jet the water.

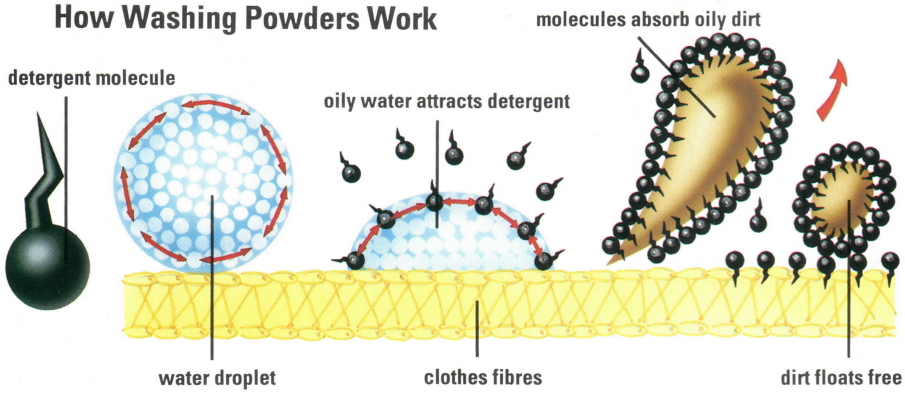
In future, ultrasound promises to provide powerful and more econo-

NO SWEAT

Antiperspirant and deodorant are often combined in one product. The former helps to stop perspiration, while the latter destroys or conceals unpleasant smells. Beads of sweat have a negative electric charge. When someone is excited, the surface of their skin becomes positively charged and attracts sweat out of skin pores. Anti-perspirant works by spreading negatively charged flecks of aluminium onto the skin surface to counteract the skin's positive charge. Sweat that is not attracted to the skin's surface dissolves back into the body.

Deodorant is mostly bactericide, which kills bacteria and stops their production of strong-smelling ammonia. Perfume is added to disguise these smells.

How Washing Powders Work



Detergent molecules *are attracted to oily dirt at the tail and to water at their round end. So detergent traps dirt particles and carries them away from clothes.*

mical cleaning methods. Ultrasound is currently used in industry to clean metal and other components. The objects are immersed in water through which high-frequency sound passes. The rapid vibrations – too quick for the eye to see – shake particles of dirt loose so they can be carried away by a detergent.

Mark Franklin

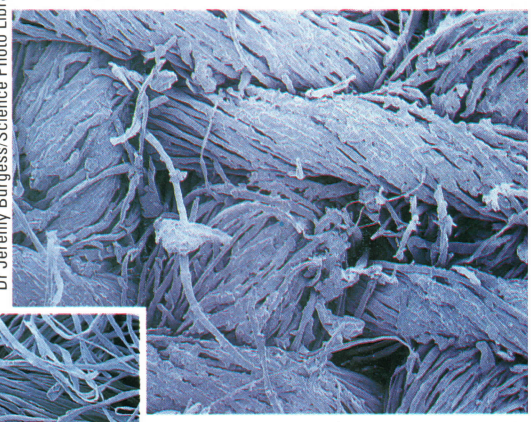
Detergents are substances used to aid the cleansing action of water.

Secondly, detergent is an emulsifier, which means it can break up the film of oil that binds dirt particles together. Lastly detergent, having got to the dirt and separated it into dispensable droplets, suspends these droplets in water to be floated away.

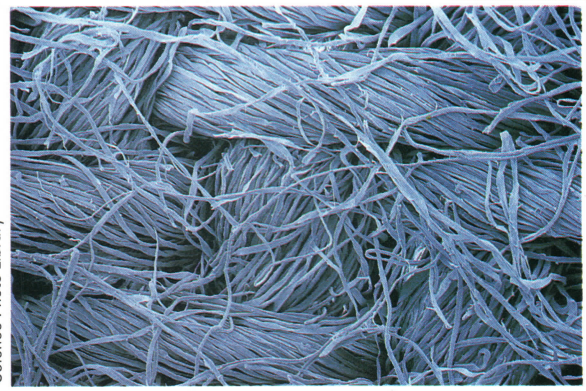
Soap is a simple detergent made by reacting animal fats or vegetable oils with sodium hydroxide or potassium hydroxide solution. It was the principal detergent until the 1940s when synthetic or soapless detergents were developed. Synthetic detergents are more effective in hard water, where the soap reacts with dissolved calcium and magnesium to form an insoluble scum called lime soap. This is responsible for that 'ring' around the bath. Lime salts also collect as scale on the element of an electric kettle.

Washing-machine powders are soapless detergents with added ingredients to keep down lather, to brighten, to scent or to bleach fabrics. 'Biological' powders have added enzymes which help to break down proteins and loosen dirt.

Aside from being effective cleaning agents, it is important that washing powders are 'biodegradable'. Biodegradable foams are those that are broken down naturally by the action of bacteria without causing damage to the environment. When flushed into rivers, foams from non-biodegradable powders prevent oxygen dissolving in the water and suffocate river life. In many countries this pollution has been made illegal and the washing powders shown to be responsible have been banned.



Dr Jeremy Burgess/Science Photo Library



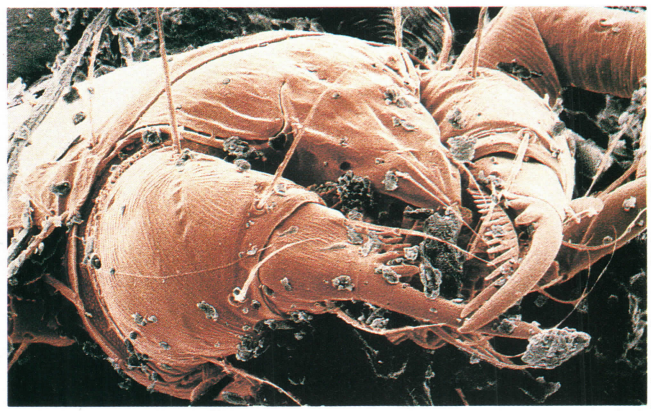
Science Photo Library

A pure cotton *shirt collar (magnified about 16 times) after one day's wear – the woven threads are coated with grease, dirt and skin flakes. The same collar (left), after being washed in an automatic machine, at 50°C.*

CHEMICAL PASTE

Peppermint oil, menthol crystals and saccharin are used to disguise the taste of other active ingredients in toothpaste:
water: the main ingredient
chalk: an abrasive to scrape the dirt off your teeth
titanium dioxide: adds a temporary white coating to any yellow remaining
optical whitening dyes: as above (also commonly used in washing-machine bleach)
seaweed extract: binds the ingredients together
paraffin oil: for a smoother texture
detergent: makes the toothpaste froth
formaldehyde: a disinfectant to kill bacteria

Microscopic dust *mites live in the home in their millions. Because of their size – this mite is magnified about 1000 times – their existence was not discovered until 1965. Although harmless to most people, dust mites can cause allergies and severe irritation.*



Dr Jeremy Burgess/Science Photo Library

They do this in three ways. Firstly they reduce the surface tension of water, allowing objects in the water to become wet. (Surface tension is the tendency of a liquid to behave as though it had a skin, because of the attraction between surface molecules. For example, a drop of water on a greasy surface forms a tight blob, but on a clean surface spreads to wet a much larger area.)

Just amazing!

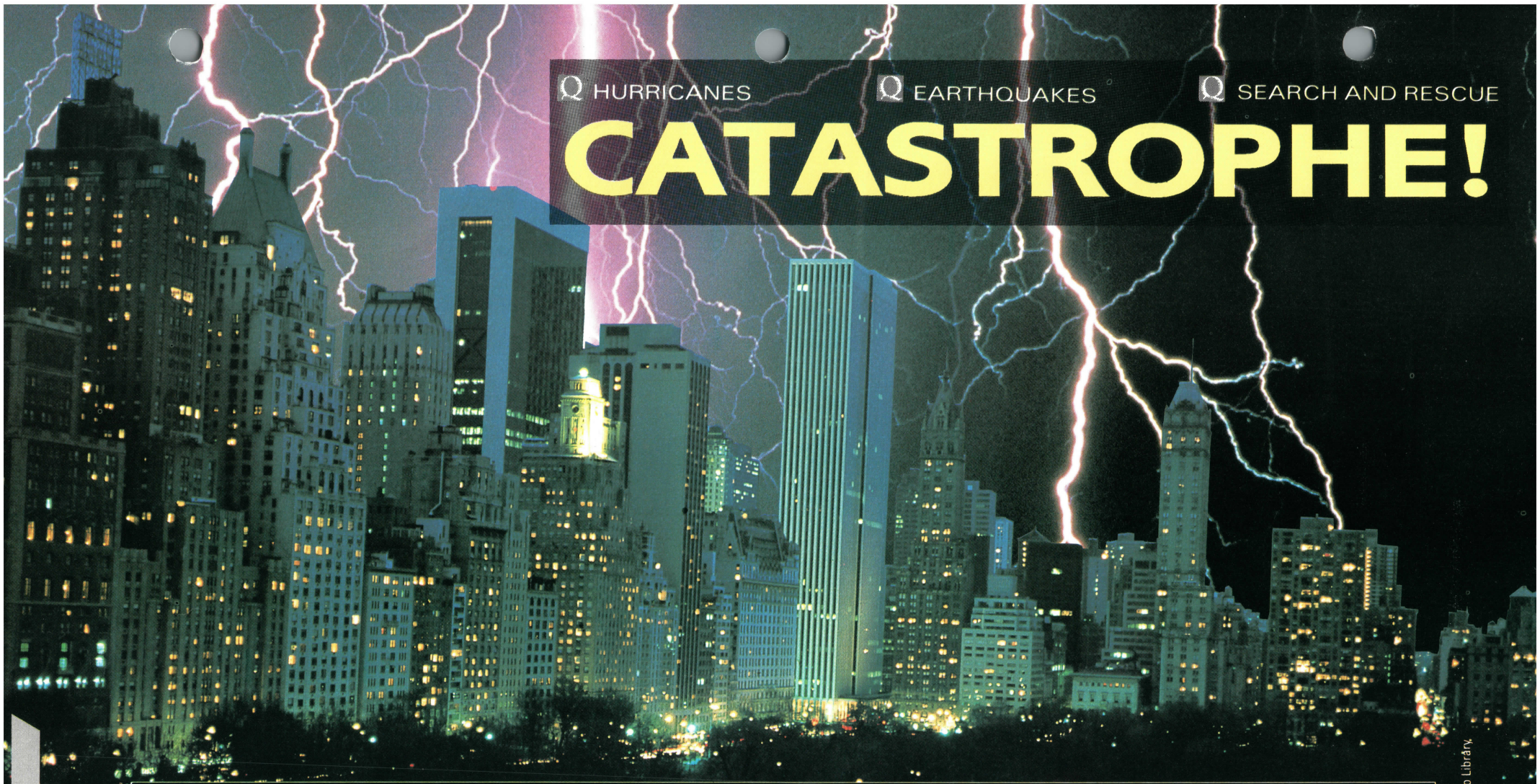
SLEEPING PARTNERS

AN ORDINARY DOUBLE BED IS HOME FOR 2 MILLION DUST MITES – MINUTE CREATURES THAT LIVE OFF TINY FLAKES OF HUMAN SKIN.

Paul Raymonde

HURRICANES EARTHQUAKES SEARCH AND RESCUE

CATASTROPHE!



ALTHOUGH MUCH HAS BEEN done to improve early warning systems and building design to minimize the effect of extreme weather conditions, homes and their occupants are still at risk when the elements strike. Then, if disaster strikes, all efforts are aimed at rescuing survivors and caring for them.

The development of Hurricane Hugo in 1989 was monitored by weather scientists, who tracked its course and gave ample warning of its force and time of arrival. This information was invaluable to the inhabitants of the Caribbean islands that lay in Hugo's path, as it gave them time to board up and batten down their homes and find shelter for their animals. Such well-planned preparation, however, did not prevent widespread devastation of buildings, as well as unavoidable damage to crops and trees on a large scale.

Decimation

The fact is that buildings in the Caribbean are ill-equipped to withstand the ravages of a 240 km hurricane. So large numbers of people were made homeless. When Hugo eventually turned to the eastern seaboard of the USA, the effect of the hurricane was much reduced. Residents shored up their houses, then evacuated the region.

Building techniques are equally important in earthquake zones. Studies on buildings in areas of major earthquakes have revealed what type of construction and materials fare best – and why. Brittle mate-

ZEFA

Without reinforcement, *seemingly well-built homes are easily toppled and smashed by hurricane-force gales.*

rials, such as bricks and unreinforced concrete, are not a good choice because they can absorb only small amounts of energy before breaking.

Shock absorbers

Buildings made of steel frames or steel-reinforced concrete, however, survive much better, especially if the internal supports are flexible so they absorb the vibrations unleashed by freak weather conditions. The 17-storey Bank of America building in Managua, Nicaragua, was built on these lines and, unlike most of the buildings around, it survived the major quake which occurred there in 1972.

The city of Los Angeles, USA, lies near the San Andreas Fault, an unstable region in the Earth's crust where earthquakes often occur. The latest big one was on 17 January 1994, when a quake measuring 6.8 on the Richter Scale shook parts of Los Angeles, bringing down road bridges and killing more than 50 people. The relatively low death toll of this and other quakes in California results largely from the fact that most buildings are now constructed to withstand earthquakes.

Search and rescue

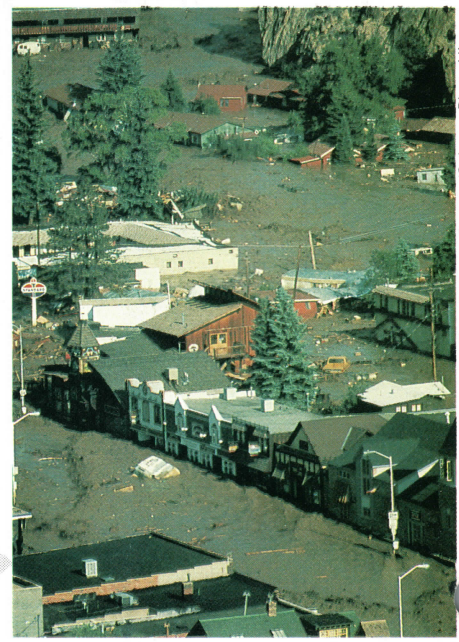
After an earthquake, there are two immediate priorities: to find anyone still alive and to make safe buildings that have become unstable. Next, plans must be made to provide shelter, food, clean water and medical supplies for survivors.

Two main pieces of equipment that help in the search for the living are the Thermal Image Camera (TIC) and the vibraphone. The TIC shows warm objects as white images against black surroundings. It can detect, for example, the hand of a partly buried, living person that would otherwise be difficult to recognise in the rubble.

The TIC cannot usually pick out someone who is completely buried – and this is where the vibraphone comes in. A vibraphone comprises a headset of earphones and two highly sensitive microphones. It can detect minute sounds – such as someone scratching on debris at depths of 9–10 metres. Where people are less deeply buried, it can even pick up breathing or a heartbeat.

LIGHTNING STRIKES

Lightning strikes the world's tallest structures frequently – the Empire State Building in New York, for example, is struck about 1,000 times a year. Yet such buildings survive undamaged, protected by lightning conductors. These used to be heavy copper wires extending from the highest point down into the ground. Today, they include horizontal strips on upper ledges – all connected to the main vertical conductor. Electric charges in storm clouds above the buildings use them as low-resistance routes to the ground, where they can be safely absorbed.



Kent & Donna Danner/Science Photo Library

The damage caused *by a broken dam can be long-lasting – the mud that penetrates the structure will ooze out of corners and cupboards for months afterwards.*

MIRACLE BABY

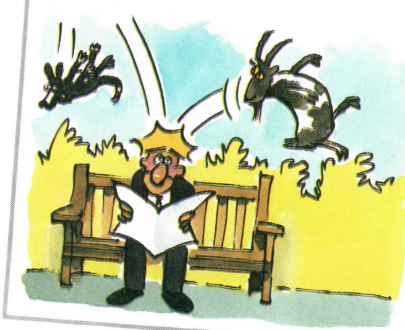
Little Juana Arias has settled down to what can only be described as a second life in Quetzacotl, near Mexico City. She is one of those dozens of babies who survive extensive devastation, while adults around them perish. Eight days after the first of two earthquakes that devastated Mexico City in 1985, Juana, who was just one day old when the earthquake struck, was pulled alive from the rubble of Juarez hospital where she was born. Her mother, also named Juana, died without trace in the same building while having a blood test. Baby Juana, after a thorough medical examination, was adopted by her aunt, Maria Arias, who has two children of her own.

Rex Features Ltd

Just amazing!

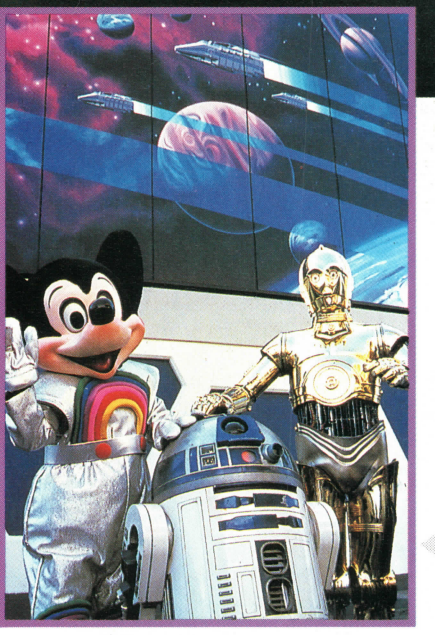
UNEXPECTED LIFT

TORNADOES HAVE BEEN KNOWN TO PICK UP DOGS, GOATS AND FISH AND DROP THEM, UNHARMED, HUNDREDS OF METRES AWAY.



Paul Raymonde

AWAY DAYS



***The Epcot centre** at Walt Disney World in Florida, stands for Experimental Prototype Community of Tomorrow.*

***At Disneyworld** you can hob-nob with the stars, such as a space-age Mickey Mouse, as well as R2D2 and C3PO from* Star Wars.

Rex Features

THEME PARKS NOW ATTRACT more people than all the sports stadiums in the world. Statistics have shown that family-oriented activities are more popular than sports events, so the leisure industry has developed the theme park.

The attraction of a real theme park is that not only buildings, but entire towns can be constructed to create the illusion of another time and place. One such park, the Walt Disney World in Orlando, Florida, is now the world's most popular tourist attraction, with around 30 million visitors a year.

Built on reclaimed Florida swampland over an area the size of London, it comprises the Magic Kingdom and Epcot Center, which stands for Experimental Prototype Community of Tomorrow. It borders a lake and contains a cluster of space-age pavilions, each of which represents one of the resources regarded as being of vital importance to the future of mankind – one of them is imagination. Another section, Future World, focuses on scientific achievements.

White knuckle rides

American theme parks are dominated by 'white knuckle' roller-coaster rides, which get more space-age all the time. The special effects experts from Hollywood are used to recreate typhoons, floods and even voyages into Space. The Walt Disney company are working with NASA to build a Space Control Mission in Houston, Texas.

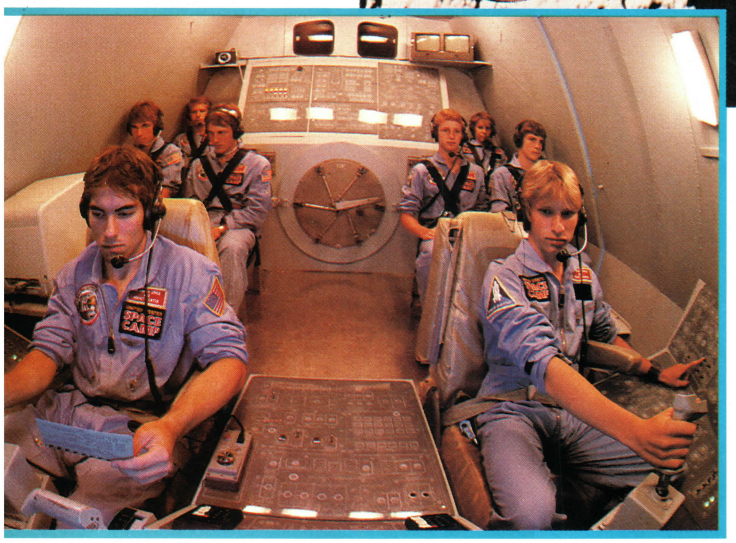
Fantasy land

A EuroDisney resort was opened in 1992 just outside Paris and covering an area about a fifth the size of that city. It has five 'lands': Discoveryland, Mainstreet USA, Frontierland, Adventureland and Fantasyland, and six 'themed' hotels to house some of the visitors. Further accommodation in log cabins is provided by the Davy Crocket Ranch about 6 km from EuroDisney in a 'heavily wooded wilderness'.

In its first year, EuroDisney reached its annual target of 11 million visitors, which makes it Euro-

US Space Camp

Holidays in Space *are almost a reality at the Space Camp, in Alabama, USA. The Microgravity trainer (right) simulates the feeling of weightlessness experienced by astronauts and can give the impression of walking on the Moon. Visitors can also learn what it is like to fly in the Space Shuttle. The centre is run by NASA, and many of the training programmes are the same as those used by real astronauts.*



EuroDisneyland *has been built just outside Paris. The model was built to show what it would look like with its lands and hotels on its 2,000 hectare site. It opened in April 1992. EuroDisney was the largest construction project in Europe apart from the Channel Tunnel.*

lasers, holograms and animated robots recreating terrifying scenes from films. For example, you may sit in front of a screen simulating a high-speed drive around a mountain road, and the seats will tilt as you skid around the bends to the sound of screeching tyres. The film may even show other cars plunging down the cliff to create real terror.

In America, one of the most popular holiday destinations for youngsters is the Space Camp in Huntsville, Alabama. Situated on the grounds of the rocket museum next door to the Marshall Space Center where the Saturn V rocket was developed, it offers various entertainments including simulations of space flights.

Children can walk on the Moon, fly the space shuttle, work in zero gravity and live through the experience of being stranded in space. With all the equipment and standards coming from NASA, the week-long courses are not only fun, but also serious science.

Water play

In the 1980s, the leisure industry has come up with the integrated leisure centre, combining a swimming pool, sauna, gym and various entertainment facilities under one roof. The idea is to create a happy mix of activities that meets modern social expectations and finds new ways of spending free time constructively.

Water is important in these establishments, some of which feature geysers, water cannons, underwater seating, surf-pools, whirlpools, waterfalls, tidal waves and cascades, as well as artificial rainstorms and wave machines. The atmosphere is meant to encourage visitors to relax in the spirit of health and fitness.

A Dutch company, Center Parcs, runs 13 futuristic controlled-

Colorific!

pe's most popular holiday destination. But it ran into financial difficulties, because it failed to make a profit. Reported problems included poor weather, comparatively few overnight stays by visitors, and hostility to the resort by some French people who viewed the enterprise as American 'cultural imperialism'.

The number of leisure centres and theme parks offering a controlled, clean environment is growing all the time. In Britain, old castles and stately homes such as Alton Towers have been turned into theme parks, and plans are afoot to convert the disused Battersea Power station into an ultra-modern centre. But the trend now is to build new theme parks from scratch.

The Walt Disney Company is planning to build a new $650 million theme park in the United States. It will focus on American history and portray such things as slavery and the civil war. Due to open in 1998, it is designed to cover more than 1,200 hectares, 60 km west of the capital Washington DC, near Manassas, the site of two Civil War battles in 1861 and 1862. The project will also include hotels, with 1,500 rooms, 2,500 homes, golf courses and a 114-ha camping site.

Disney

This huge land development project has attracted criticism from some who believe it will lead to increased urbanisation, pollution and extra traffic, and also from historians who fear that it will trivialize American history.

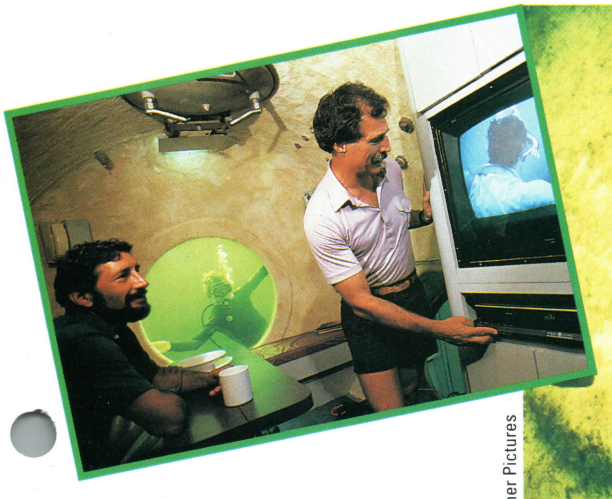
Horror films

The emphasis in the future will be less on roller-coasters and more on

Lerosey/Jerrican

***The Center Parcs** have controlled-environments, so you can swim and sunbathe all the year round in warm weather conditions.*

***Jules' Undersea Lodge,** is 5 fathoms under the sea in Key Largo, Florida, USA. Guests must be qualified SCUBA divers to even reach the front door!*



Gamma/Frank Spooner Pictures

environment holiday villages across northern Europe.

The Centre Parc villages have 7,600 villas and 250 apartments, and each has as its centrepiece an enormous transparent dome containing swimming pools in a semi-tropical environment.

Five fathoms under the sea is Jules' Undersea Lodge, the world's first and only underwater hotel. Built in a tropical lagoon in Key Largo, Florida, it can accommodate up to six divers in air-conditioned suites that include video, television, stereo, and global communications.

Divers only

The view out of the windows is reported to be unlike any other. So is access to the hotel – guests must be qualified SCUBA divers or obtain a Resort Course Dive Certification before they are allowed to descend using tethered breathing lines. Once in the Lodge, they are free to do what they want.

Futurism is also catching up with traditional spectator sports. In America, people are now going to sports stadiums to watch television. Massive indoor sports palaces are being constructed to house full-size football pitches in warm, comfortable surroundings featuring restaurants, car parks, central heating and huge television screens.

Super Stadiums

The Astrodome in Houston can seat 60,000 people for a game of American football or 66,000 people for a boxing promotion.

This is nothing compared to the Superdome in New Orleans, which can seat almost 76,000 people and has six television screens measuring 6 by 8 metres suspended from a 68-tonne television rostrum.

Robert Holland

Live and on TV

Spectators can watch the game from all possible angles whenever they get bored with the live action in front of them. Not only can they see slow-motion replays of the critical moments in the game, they can also

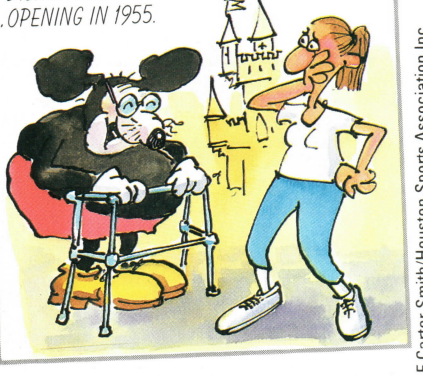
F Carter Smith/Houston Sports Association Inc

***Huge television screens** give close-up views and instant action replays at the Houston Astrodome. One of the most modern stadiums in the world, with a covered roof and comfortable seating for around 60,000 spectators, the Astrodome is used for many events.*

Just amazing!

DISNEYFAN

ON 1 SEPTEMBER 1989, CLAUDIA MASSON FROM FRANCE BECAME THE 300 MILLIONTH PERSON TO VISIT DISNEYLAND IN CALIFORNIA SINCE ITS OPENING IN 1955.



Paul Raymonde

Daudier/Jerrican

watch close-ups of their heroes.

The supporters have become accustomed to the advantages offered by these new stadiums. The games are never postponed because of bad weather, and enough of the old stadium atmosphere remains to convince them they are not watching a game on a screen in their living rooms.

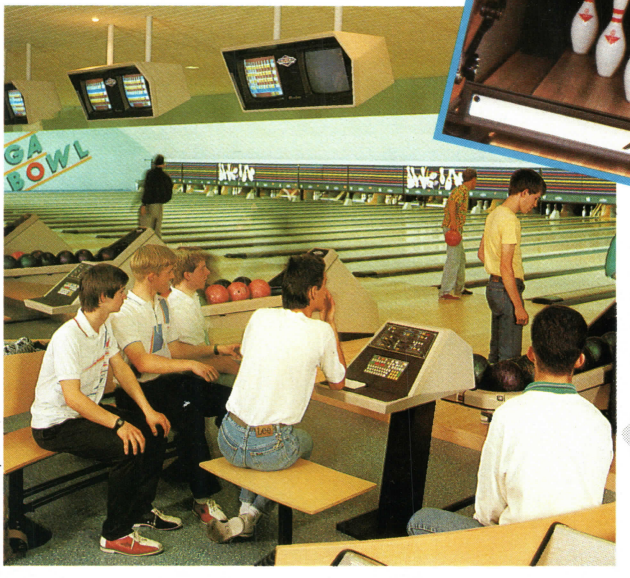
Stadium design has been revolutionized in other ways. The Oahu stadium in Hawaii is built on huge hydraulic air cushions, so that the shape of the stands can be changed from a rectangle, for the American football season, to a diamond shape for baseball during the rest of the year.

Indoor golf

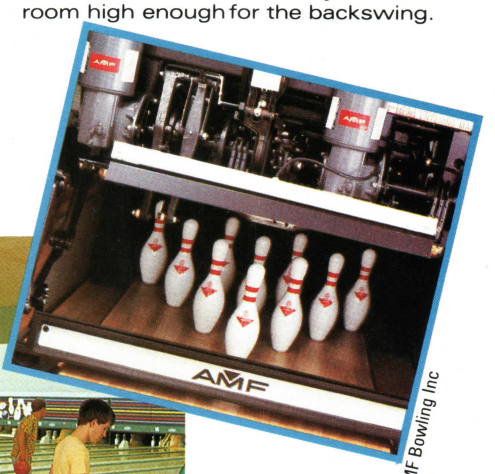
A similar trend towards high-tech solutions can be seen in Japan, whose estimated 10 million golfers cannot find enought courses in a country where space is at a premium. No more than 15 per cent of Japanese golfers ever play on a real golf course; the rest have to resign themselves to hitting balls at one of Japan's 5,000 driving ranges.

There are even multi-tiered driving ranges to allow more golfers to practise at once. But now a golf simulator called Joytech enables golf-obsessed Japanese to play a game on a video screen in their living room, hitting a tethered ball with a normal club and watching the computer calculate its direction and distance. All that is needed is a room high enough for the backswing.

Multi-tiered golf driving ranges *are one solution for the great demand for golf facilities in overcrowded Japan.*



Allied Leisure plc

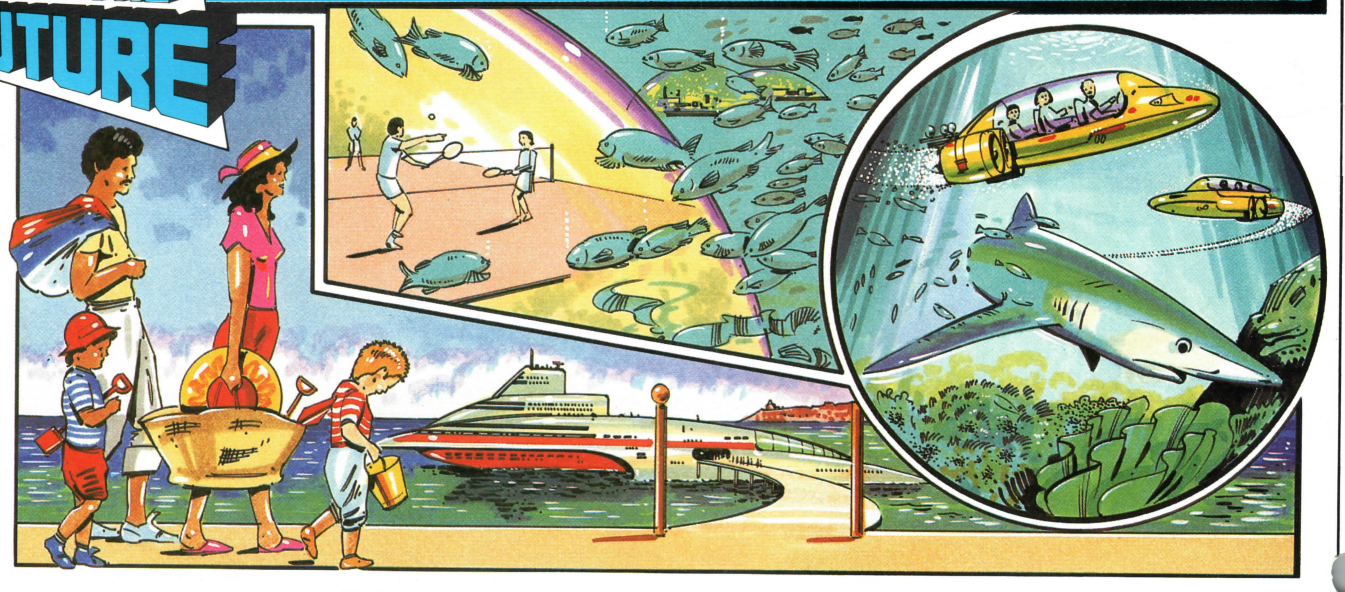


AMF Bowling Inc

Ten-pin bowling alleys *are popular all over the world. Now they are controlled by computers, from the electronic scoreboards right through to repositioning the 'pins' or skittles (above) and returning the bowling balls.*

INTO THE FUTURE

HOLIDAY BENEATH THE WAVES



Joe Lawren

▲ *As land space becomes increasingly congested the family of the future will head for the sea bed – the last 'undiscovered' place on Earth.*

▲ *Holidaymakers will stay in a vast, heated, pressurized bubble. The will sleep, eat and play games in artificial sun while undersea creatures look on.*

▲ *The undersea lodge will provide unique opportunities to see and hear weird and wonderful sea creatures living in their natural habitat.*

Spectrum Colour Library

WILL TO WORK

- HUMAN RESOURCES
- TEAMWORK
- MOTIVATION

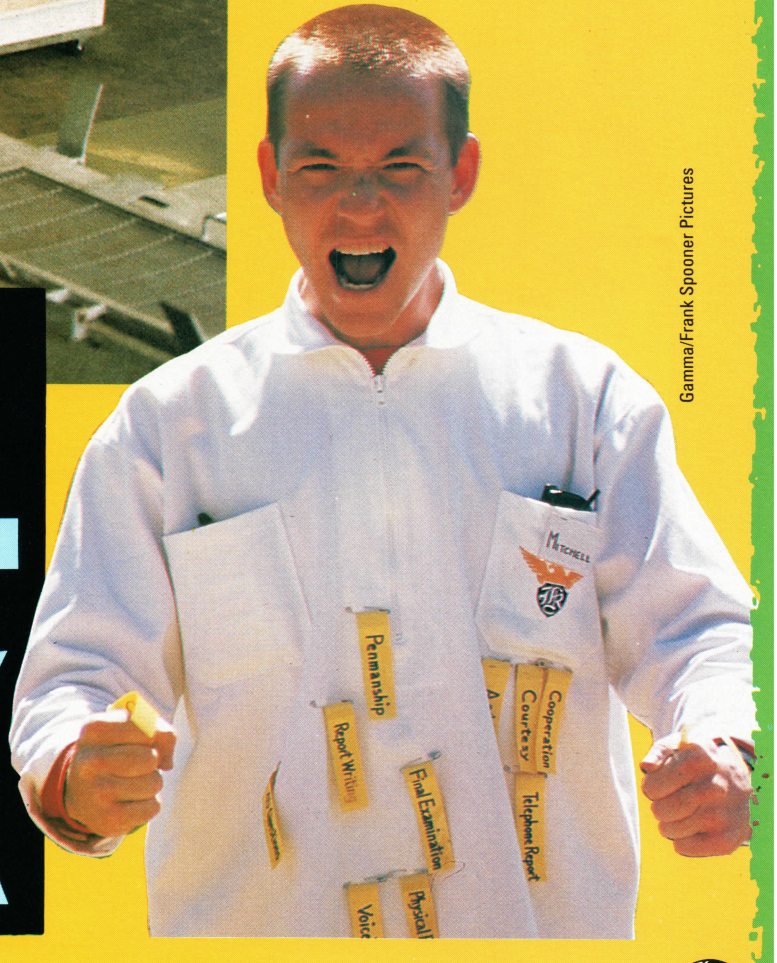
THE LABOUR FORCE IS THE economic lifeblood of the industrialized world. Every day factory workers help produce millions of goods from television sets to toothbrushes to soft toys. The way employers motivate their workers depends on the way they view human nature and behaviour.

Manager X supposes that the average human being has an inherent dislike of work and will avoid it whenever possible. He thinks his workers shun responsibility and have little ambition. Believing that authority is the way to control, manager X dictates orders and threatens his staff with punishment in order to make them work hard.

Management

Manager Y is more forward looking in his attitude. He believes that work is as natural to the average person as is play or rest. He under-

Intensive training, *away from the workplace, can be motivating. The employee (below) has been tested on various skills as marked by flags on his jacket.*



Gamma/Frank Spooner Pictures

stands that if his workers are commited to their jobs, they will exercise initiative and will seek responsibility. Manager Y's theory is concerned with creating a good relationship between employers and employees. People work hard if they feel their jobs are meaningful, and their managers are supporting them.

Multi-skill training

The Swedish car manufacturers, Saab, are commited to teamwork. At their plant in Malmö, the workforce is divided into groups of six to twelve workers. Each team member is expected to take his or her turn as group leader – to speak for the others in dealings with management and other groups. Each member is also trained to do the jobs of every other group member.

Winning team

Factory workers in Sweden are viewed as a resource rather than a cost to be reduced with the introduction of new technology.

McDonald's, the American hamburger chain, compares a well-run restaurant to a winning baseball team. All workers are thought of as 'crew members'. Senior managers are encouraged on to the 'field' to pay attention to, and train, employees, and to ensure a good standard of service.

The United States is the world's most industrialized nation, accounting for around half of the world's industrialized goods. There is little social distinction in the US between white collar workers (people who work in an office) and blue collar workers (people who work on the factory floor). And workers are encouraged to rise through the ranks from blue collar worker to white collar worker to management.

Class system

Japanese work ethics are markedly different to those of the US. Career advancement through rigid class divisions is rare – except when graduate sons of blue collar workers are admitted to management by virtue of their qualifications.

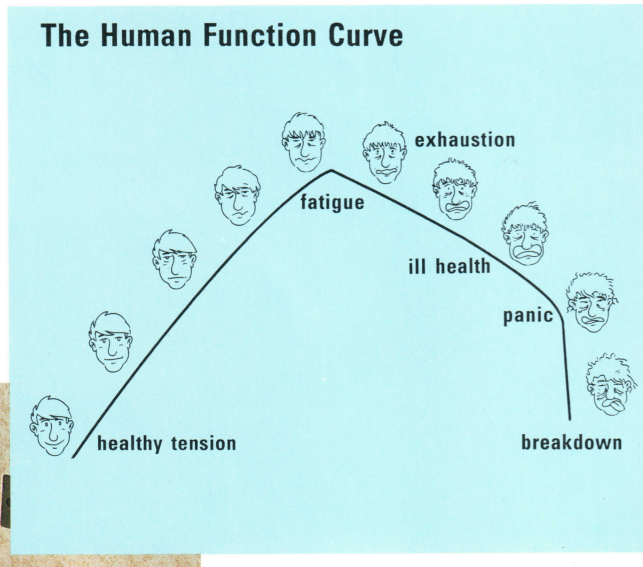
Company loyalty in Japan is common – most people expect to be with one company until they retire. Workers move up the hierarchy automatically as they get older, thus they do not compete with their colleagues for promotion.

Gamma/Frank Spooner Pictures

Survival games *combine sport, cunning and competition with good fun. These employees are learning to use air pistols that fire paint pellets before beginning manoeuvres.*

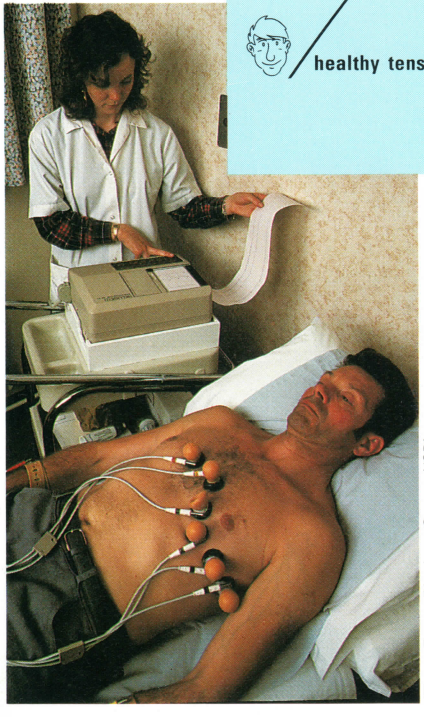
Toyota Motor Corporation

The Toyota Idea Olympics *are held each year to promote creativity, enhance engineering skills and develop friendship among employees. The brief for this entry was to build a 'sci-fi' vehicle for wild terrain.*

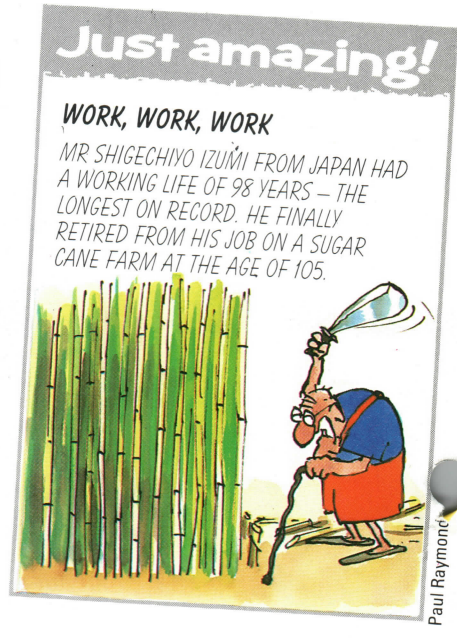


Will

Healthy tension *increases work performance, but too much leads to fatigue – and exhaustion. A small amount of extra pressure at this stage can cause mental breakdown. Regular health checks (below) are one way to monitor stress levels.*



Simon Fraser/Hexham General/SPL



Paul Raymond

***Cleaning** oil-polluted beaches is time-consuming and expensive. Volunteers spend months trying to save seabirds (inset, left) and other wildlife*

Rex Features Ltd

OIL SPILLS

DISPERSANTS

BOOMS AND SKIMMERS

OPERATION CLEAN-UP

Norman Myers/Bruce Coleman Ltd

THE WORST OIL SPILL IN American history occurred when the *Exxon Valdez* ran aground off the southern coast of Alaska on 24 March 1989.

Through a gaping hole in the ship's side, 38,000 tonnes of thick, crude oil escaped into Prince William Sound. The slick spread nearly 900 km to the tip of the Alaskan Peninsula and covered 7,800 square km of ocean. As the oil was washed ashore, it wreaked havoc with local wildlife.

In a 1993 report the official death toll included 580,000 sea birds, 5,500 sea otters, and 147 bald eagles.

Most of the sea birds that fell victim to the Valdez spill had their feathers coated in oil as they dived into the polluted water in search of fish. Sea otters were even more vulnerable – oil destroys the heat

NUCLEAR WASTE – THE THREAT TO OUR FUTURE

Potentially more dangerous than oil pollution is the radioactive waste from nuclear power stations.

The problem of where to store radioactive material has caused a lot of controversy. In Britain until 1982 some waste with low or medium radioactivity levels, such as reactor components and protective clothing, was dumped at sea. But now 90 per cent of Britain's nuclear waste is buried in landfill sites.

The most highly radioactive waste is stored at the fuel reprocessing plants where it is produced. This waste is encased in lead and concrete and will eventually be stored in a huge system of tunnels, hundreds of metres underground. It will have to remain there for at least 1,000 years before it becomes harmless.

Black Star/Colorific!

Gamma/Frank Spooner Pictures

insulating properties of their fur and, once contaminated, they simply froze to death in the icy sea.

A less obvious but equally catastrophic result of such a disaster is the effect on animals involved in the food chain. For example, bald eagles, feeding on the bodies of sea birds washed ashore from the Alaskan spill, often died from the oil they swallowed. In other cases, an eagle's feathers picked up oil that was then smeared on to its eggs when the bird returned to its nest. As the black tar worked its way through the porous eggshell it killed the growing chick inside.

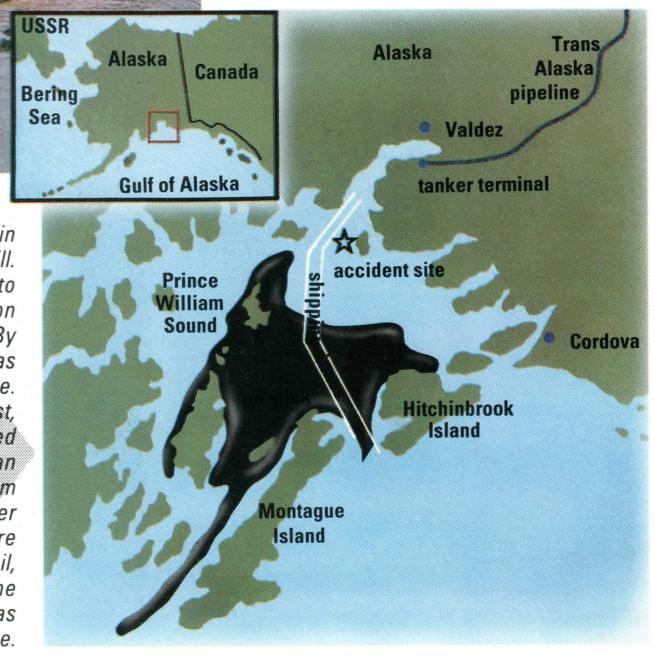
Adding chemicals

Various methods exist for clearing up oil spills, but none is reliable.

About 100 different chemicals, known as dispersants, are available for treating oil spills. Each works in the same way as washing-up liquid – by breaking the oil up into small droplets that are then dispersed by the ocean. To be effective, the dispersants have to be applied almost immediately. Otherwise, as in the case of the Valdez spill, the sea churns the slick into a tar-like emulsion. This 'mousse' responds badly to dispersants which, even in ideal conditions, will dissolve only about one third of a slick.

Setting fire to spilt oil also works best if it is done as quickly as possible after the accident. One way to start the blaze is to drop an igniter, such as a large fire-cracker, from the window of a helicopter. In the near future, airborne lasers will set slicks alight. A continuous beam from one laser will gradually heat the slick to make it give off a dense cloud of vapour, then a sudden, intense pulse from a second laser will cause the vapour to ignite.

A third approach is to surround and skim off the oil. Booms are large, fireproof tubes that confine a slick while skimmers scoop the oil out of the water. The trouble with this method is that oil seeps under the boom if the water current flows slowly, at a rate of 1 km/h or less. High winds and waves cause the oil to slop over the top of the boom.



Mark Franklin

***Speed** is essential in containing an oil spill. It took 36 hours to surround the Exxon Valdez with booms. By then the oil flow was uncontrollable. Spreading southwest, it eventually reached the tip of the Alaskan Peninsula, 900 km from the wreck. Skimmer boats (above) were sent to clear the oil, but much of the damage was irreparable.*

WAR ON WASTE

Gamma/Frank Spooner Pictures

Accidents involving toxic chemicals have become so frequent in America that emergency response teams have been set up (above). Trained to work in protective suits complete with breathing apparatus, the teams must reduce the danger as quickly as possible after a spillage. Often, whole communities have to be evacuated.

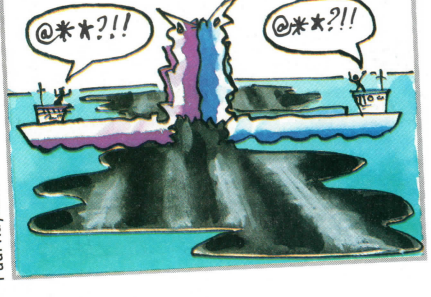
Superbugs

In the future, it may be possible to release 'superbugs' – micro-organisms that have been genetically engineered to feed on oil and break it down into harmless substances. Artificial lifeforms such as these will have to be carefully monitored and controlled in case they affect the delicate balance of life in the sea.

Just amazing!

WHAT A WASTE!

THE WORLD'S LARGEST OIL SPILLAGE OCCURRED WHEN TWO SUPERTANKERS COLLIDED OFF TOBAGO ON 19TH JUNE 1979, SPEWING OUT 300 TONNES OF CRUDE OIL – ENOUGH TO HEAT AN AVERAGE HOUSE FOR 90,000 YEARS.



Paul Raymonde

***Oil spillages** are not the only cause of pollution on beaches. Long stretches of coastline can be devastated by toxic waste from factories. This beach in South Humber, Britain has been stained red by iron ore deposits from a chemical plant.*

Bob Edwards/Science Photo Library

Man's dream of flight *comes true in* Birdy – *thanks to movie special effects.*

Today *Man really* can *fly – using technology and by harnessing old-fashioned leg power.*

MAN- POWERED FLIGHT

TO FLY LIKE A BIRD IS A dream that stretches back to antiquity. But only recently, after the development of jet engines and Space travel, has man-powered flight become possible.

In 1959, the British industrialist Henry Kremer offered a prize of £5,000 to the first entrant to fly an aircraft round a one-mile, figure-of-eight course using muscle power alone. Eighteen years later, the Kremer prize — now increased to £50,000 — was won by Paul MacCready and Peter Lissaman with their lightweight plane, Gossamer Condor.

The designers worked out that a machine the same weight as a hang-glider, but with a wing area three times bigger, could just about be kept airborne by a fit athlete. The pilot would sit in a streamlined cockpit and pedal hard to keep a large propeller slowly turning. Long, narrow wings, spanning almost 30 metres, would give the aircraft excellent lift and allow it to cruise at speeds as low as 16 km/h without stalling.

Aerodynamics

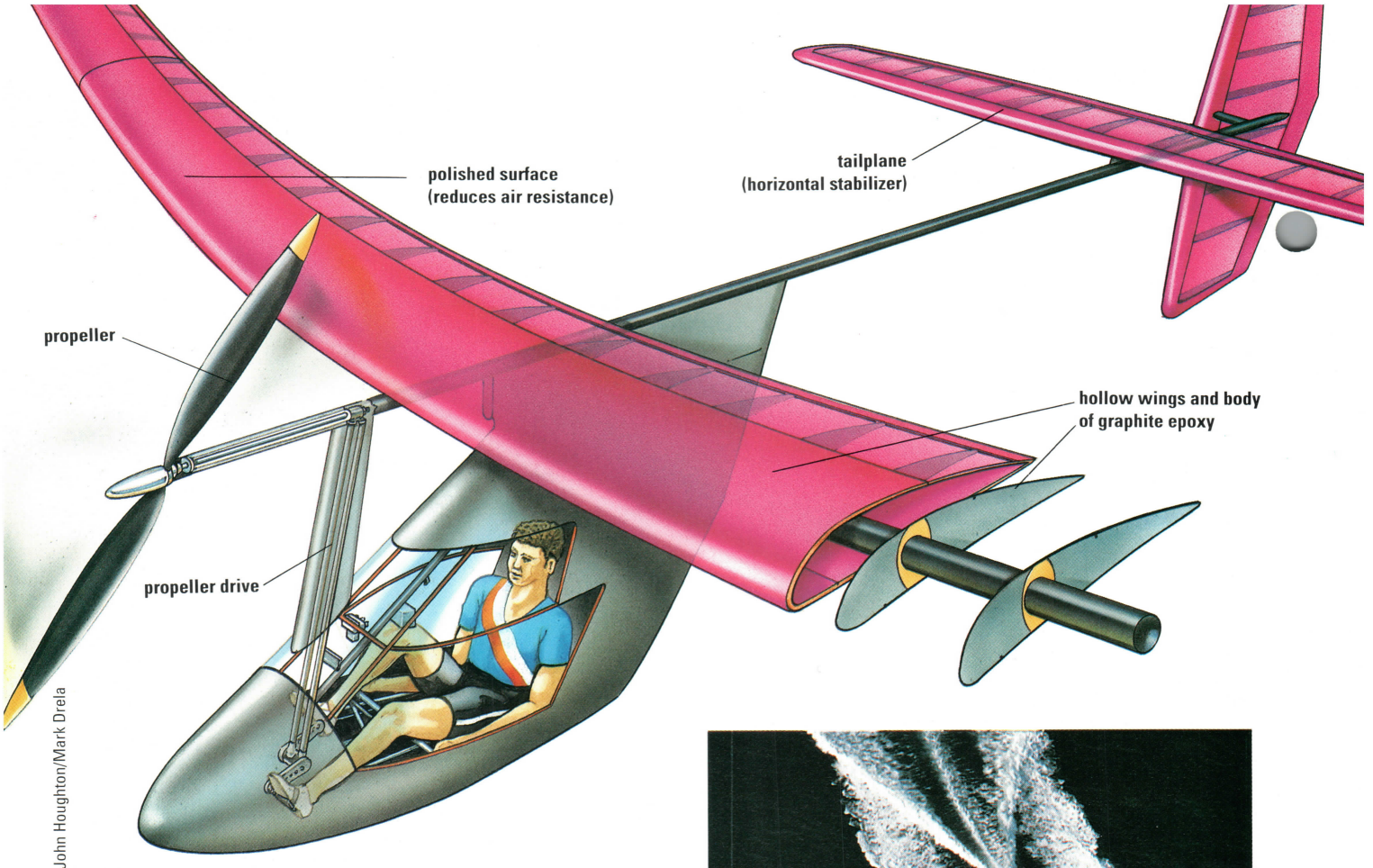
The ability to fly slowly is essential in a man-powered plane because the drag, or air resistance, on the craft grows rapidly with increasing speed. Beyond a certain point, the drag is so great that no amount of pedalling by the pilot will make the machine fly. The need for low speed, in turn, dictates the width and area of the wings.

There are various ways a man-powered aircraft can be made to fly, including flapping its wings like a bird or using jets of compressed air. But the best way of transforming the mechanical power generated by the pilot's legs into a forward thrust is with a propeller. This must be large enough to push sufficient air back so that the plane is driven forward and kept airborne without making the plane too heavy.

Design

Weight is the single most important factor in the design of a man-powered aircraft. Every component must be as light as possible and yet have the strength to withstand the forces acting on it during flight. For the Gossamer Condor the designers

Peter F Selinger



John Houghton/Mark Drela

used a combination of old, familiar materials and new, hi-tech ones.

The main spars and ribs of the Condor's wings were constructed from heat-treated aluminium tubing, the walls of which were as thin as six thousandths of a centimetre. Stainless-steel piano wire was used to brace the wings, while corrugated cardboard formed the wings' leading edges. For the smooth skin of the wings and rudder, a brand new, tough and lightweight plastic film called Mylar was employed.

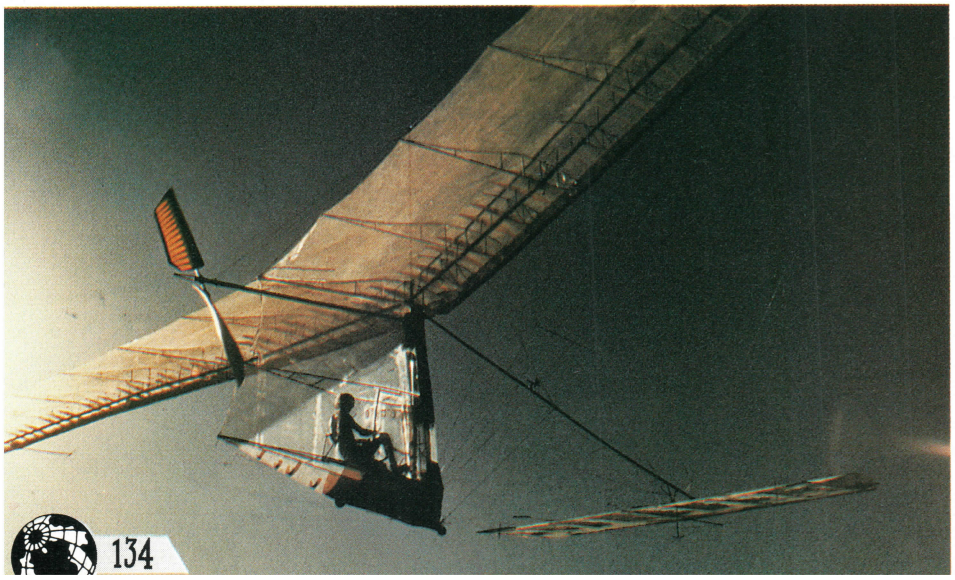
Breaking records

Incredibly, when the Gossamer Condor took the Kremer prize on 23 August 1977 after a flight of just over 2 km, it weighed only 94 kg including its 62 kg pilot! Two years later, it was superseded by the even lighter

***A team** of 36 people took three years to design and build Daedalus (above and right). It was built with graphite epoxy – a material 10 times stronger and eight times stiffer than the equivalent amount of aluminium. It has a wing-span of 34 metres, yet weighs only 31 kg.*

***The Gossamer Condor** proved, in 1977, that a plane as light as a hang-glider could be kept airborne by muscle power alone.*

Charles O'Rear/West Light/Art Directors Photo Library



Royal Aeronautical Society

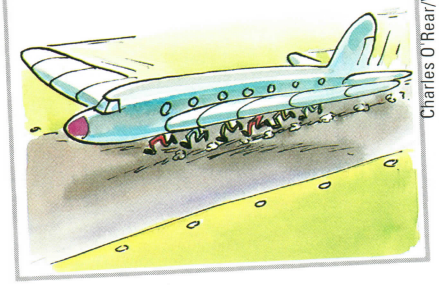
MUSCLE POWER

Because even the lightest man-powered aircraft take a tremendous amount of physical effort to keep airborne, first-class athletes make the best pilots. The world champion cyclist Eddie Merckx can output a steady 450 watts of power for at least an hour. By comparison a healthy man might be able to generate 800 watts by pedalling hard, but he could not sustain that for more than a few seconds. His output over 5 minutes would be nearer 300 watts – only slightly more than that needed to keep a craft like the Gossamer Albatross airborne.

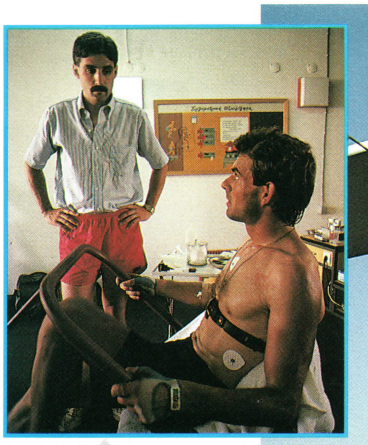
Just amazing!

WINGING IT

ALTHOUGH IT WEIGHS ONLY 32KG, THE WING SPAN OF THE MAN-POWERED PLANE GOSSAMER CONDOR IS OVER 28 METRES – AS GREAT AS THAT OF A DC9 JET AIRLINER.



Paul Raymonde



Charles O'Rear/West Light/Art Directors Photo Library

The cyclist *chosen to power Daedalus, Kenellos Kanellopoulos, trained by cycling up to 800 km per week.*

John Houghton

Aerodynamic drag *is minimized and pedalling more comfortable if the pilot is enclosed in a shield of transparent plastic.*

Gossamer Albatross, which became the first man-powered aircraft to fly non-stop across the English Channel. Its 36 km journey from Folkestone in England to Cape Gris Nez in France took 2 hours and 49 minutes, and at times its pilot — near to exhaustion — had to pedal desperately hard as the craft came perilously close to clipping the crests of the waves.

Now, a new generation of man-powered flying machines has started to appear. One of these was built by scientists from the Massachusetts Institute of Technology, USA, to follow in the path of the legendary Greek inventor, Daedalus. On 23 April 1988, the Daedalus man-powered plane completed a flight of 119 km from Crete to the tiny Greek island of Santorini at an average speed of just under 30 km/h.

The latest man-powered aircraft, like Daedalus, are smaller, lighter, and faster than ever. They do away with, for example, complicated wing parts such as struts and braces. New structural materials like graphite epoxy (used in the building of jet fighters) are incredibly lightweight — yet so strong that just a single narrow strip can support an entire wing. The wing can also be made rigid enough to be fitted with ailerons (flaps on the rear parts of the wings) to control the plane movements more accurately.

Royal Aeronatuical Society

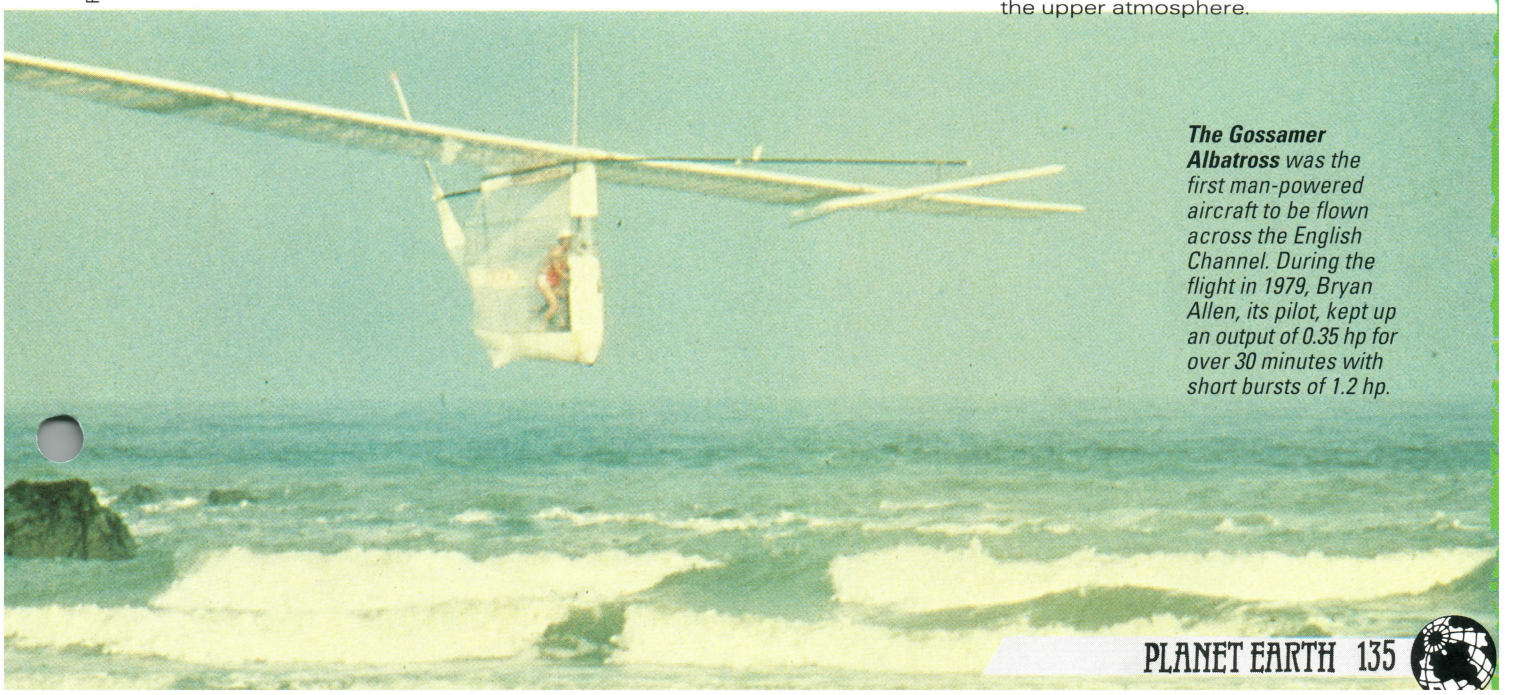
Power back-up

To gain altitude or turn corners, the pilot has to supply more power. One way he can do this is simply by pedalling harder. But some recent aircraft carry a battery that can be charged up by pedalling before take-off. During flight the pilot can draw on this stored power by flipping a switch connected to an electric motor to help turn the propeller. A gauge shows how much charge the battery has in reserve and how much current is being used.

A number of prizes are being offered by the British Royal Aeronautical Society to encourage the development of more practical man-powered aircraft. Some of these, fitted with batteries, may be able to reach speeds of 85 km/h. Others will provide greater safety and ruggedness, while still others will extend the ability of large, low-power craft to fly slowly over long distances.

Planes of the Future

Pedal-driven planes may become more popular than hang-gliders or microlights early in the next century. Ultra-lightweight planes, powered only by battery and electric motor, could act as high-altitude platforms for reconnaissance work (such as surveying), relaying communications, or helping with research into the the upper atmosphere.

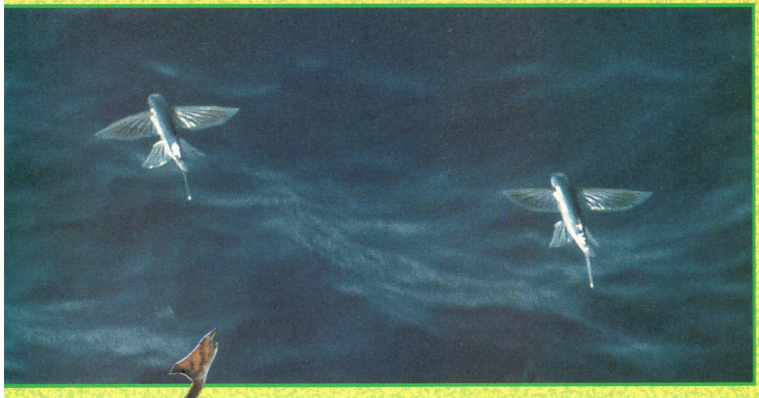


The Gossamer Albatross *was the first man-powered aircraft to be flown across the English Channel. During the flight in 1979, Bryan Allen, its pilot, kept up an output of 0.35 hp for over 30 minutes with short bursts of 1.2 hp.*

Catkins *of the alder tree are free swinging arrangements of uni-sexual flowers. Catkins are designed to catch the wind and so spread the pollen from their flowers over a wide area.*

Four-winged flying fish *skim the surface of the Red Sea, beating the lower part of their tails in the water up to 50 times per second. They reach speeds of over 60 km/h before rising into the air. One has been observed to remain airborne for 90 seconds, travelling a distance of 1109 metres.*

Jane Burton/Bruce Coleman Ltd



Dr Jeremy Burgess/SPL

LR Dawson/Bruce Coleman Ltd

The flying fox *of the Indian Ocean islands is not, in fact, a fox but a large fruit bat.*

Cockchafers *spend their first four years as larvae feeding on plant roots underground.*

A Warren/Ardea London

Flying frogs *do not actually 'fly' – they use their webbed feet to glide between trees and break their fall to the ground.*

A dragonfly *begins life under water as a larva. When fully grown, it crawls up a stem and sheds its skin. Blood then pumps into its wings to expand them.*

Alain Compost/Bruce Coleman Ltd

The flying lizard *glides by opening membranes supported by ribs.*

Plumed seeds *of the dandelion weed can be carried hundreds of kilometres by wind.*

Stephen Dalton/NHPA

Adrian Davies/Bruce Coleman Ltd

MOUNTAINS OCEANS ICE KINGDOMS

STRANGE WORLDS

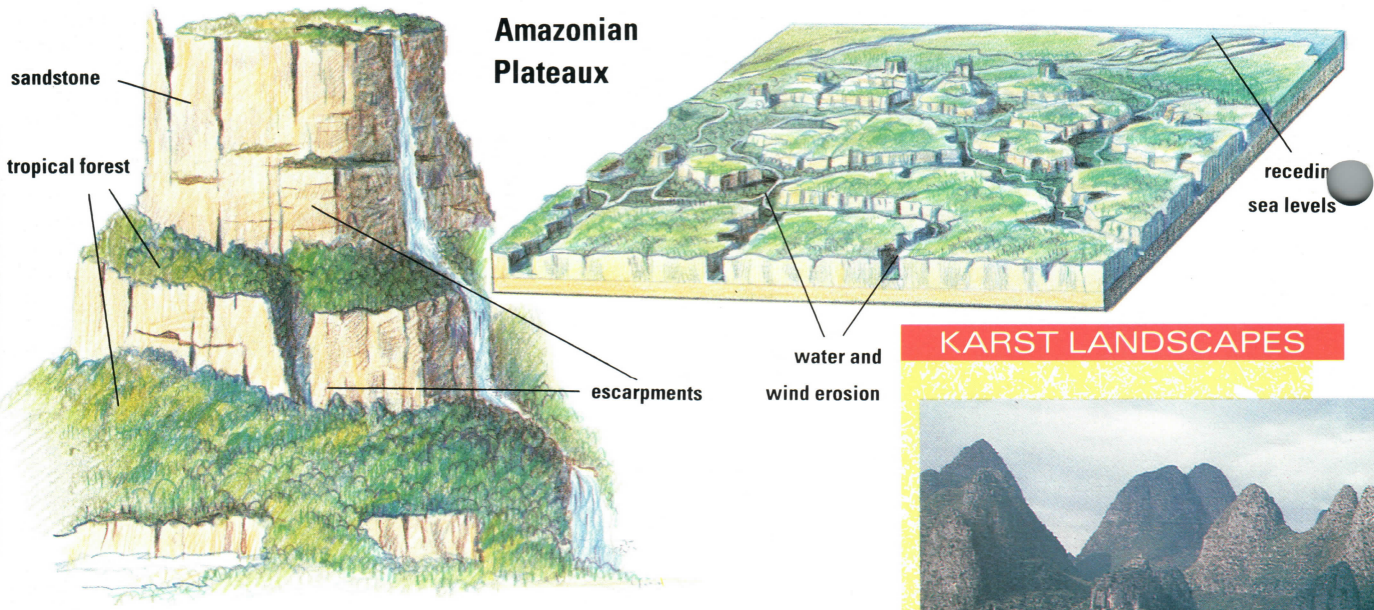
***Mammoth Cave** in the USA, consists of a seemingly endless labyrinth of chambers, making it the longest cave in the world. The Blue Holes in the Bahamas (inset) were once above sea level but are now submerged.*

There are still parts of Planet Earth that remain unconquered. They include mountain ranges, vast deserts, the ocean depths and dense rainforests. Man's failure to make inroads into these areas has ensured the survival of many unique species of plantlife

These hidden, isolated corners of the world are largely unexplored because man is unable to overcome physical barriers to reach them.

On top of Mount Everest – at 8,848 metres, the world's highest peak, – temperatures can fall to -36°C and winds can reach speeds of 240 km/h. It is almost impossible to move about without breathing apparatus, though since it was first climbed in 1953, some climbers have actually reached the summit without the use of bottled oxygen.

Mountains make up about 5 per cent of the Earth's land mass. The major mountain ranges include the Rockies and Andes of America, the Alps and Pyrenees of Europe, the Atlas Mountains of North Africa and the Himalayas of central Asia. In each range there are tracts of land hundreds of square kilometres in area that remain isolated due to their difficult terrain and climate. Except in warm regions, very high ground is permanently covered in snow. Lower down, even where there is access by road, rail or air, communication links are cut off for much of the year by



After Pierre Mion/© National Geographic/Matthew White

***Massive sandstone plateaux** – known as* tepuis *by local indians – rise out of the steamy jungles of south-east Venezuela. Fewer than half of thse islands in the sky have been explored.*

rivers of meltwater, avalanches or rock falls.

On all mountains, climate varies according to altitude, sunlight, wind, rain, snow and soil. For every increase in altitude of 1,000 metres, temperature decreases by 6.5°C and air pressure by 100 millibars. Winds become stronger the higher one goes and create a chilling effect that further decreases the temperature. High up, the air also contains much less oxygen than at sea level. Above 3,000 metres many people experience mountain sickness; above 6,000 metres reduced air pressure makes breathing difficult.

Peak fitness

In order to explore remote mountain areas, a great deal of preparation and equipment is needed. A recent ascent of the 7,396 metre-high Pik Pobedy in eastern Kyrgyzstan required sixmonths planning, an initial two weeks acclimatization and a week's strenuous training at 4,000 metres. The climbers and their equipment had to be airlifted by helicopter to the base camp, 20 km from the peak. To conquer the mountain, the 15-man team had to overcome ice walls 20 metres high, a 13-metre ice overhang and a snowstorm that imprisoned the climbers for two days. The ascent took one week.

Pitch black

Conquering the ocean depths involves overcoming two major problems – darkness and water pressure. Sunlight penetrates the seas to a depth of only about 200 metres. Below this, it becomes increasingly dark until, at about 1,500 metres, it is pitch black. It is also only about 4°C.

Water pressure increases by 1 kg per sq cm with each 10-metre descent from the surface. Breathing ordinary air at high pressures results in a build-up of nitrogen in the blood. If a diver with normal breathing apparatus surfaces too quickly, the nitrogen turns back to gas in the bloodstream. This causes severe sickness known as the bends. The deepest that a diver can go with ordinary diving gear is about 100 metres.

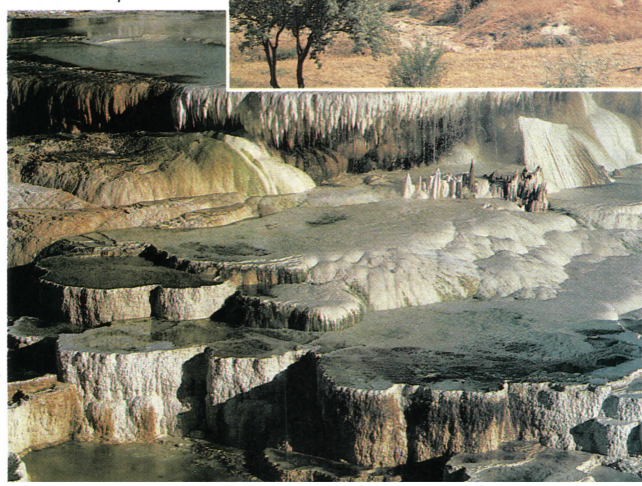
Below about 120 metres, water pressure is sufficiently great to crush the human body. Using a special diving suit, depths of about 300 metres can be reached. But most of the ocean world is deeper than this – the average depth is 3,850 metres and

KARST LANDSCAPES

Tony Waltham

These limestone towers, near Guilin, China, are a result of a process called karst erosion. Karst refers to landscapes of limestone that have been heavily eroded by groundwater. Charged with carbon dioxide from the atmosphere, water becomes mildy acidic and capable of dissolving limestone. It seeps through fissures in the rock, carving out irregular formations.

***These pillars in** Capadoccia, south-east Turkey, were used as homes during the Middle Ages. Armenian communities carved rooms, stores and churches out of the soft, volcanic ash. The pillars are made of fine-grained rock formed as a result of volcanic explosions.*



Tony Waltham

***Travertine terraces** are caused by water, superheated by molten rock, passing through underground limestone. The white mineral is redeposited on the surface when the water cools.*

Melinda Berge/Bruce Coleman Ltd

1,602 metres below ground. The most extensive cave system is the Mammoth Cave and Flint Ridge system in Kentucky, USA, which has a total mapped length of over 500 km.

Constant danger

Cave explorers use rope ladders, mountaineering and diving equipment and miners' helmets. They have to descend deep pits, crawl through narrow cracks in the rock, paddle along streams and swim through water-filled passages. All the time there is the danger of falling rocks and of water levels rising as rain falls on the land above.

Despite the continued worldwide destruction of natural forest for timber or farmland, huge areas of unexplored jungle still exist. The term jungle is very often applied to tropical rainforest, where trees grow and close together, forming an almost continuous, thick layer of foliage 30 to 40 metres above the ground. The densest jungles are found in Central and South America, West Africa and on the major islands of Indonesia.

Tony Waltham

the deepest point, the Marianas Trench in the Pacific Ocean, is some 11,000 metres beneath the surface. Such areas can only be explored with specially pressurized deep-submergence craft, such as bathyspheres and unmanned, remote-controlled research vehicles.

Mystery

Even with such vessels, we know little about the ocean depths. The Sargasso Sea in the North Atlantic ocean for example, still holds many mysteries. Its extent and position vary from summer to winter as the Gulf stream currents change direction, yet it remains warm all year. In its surface waters, a yellowish algae thrives, providing food for adult eels from rivers in Europe and North America. The eels spawn in the Sargasso Sea, but exactly where is not certain. And how they find their way across the Atlantic is also a mystery.

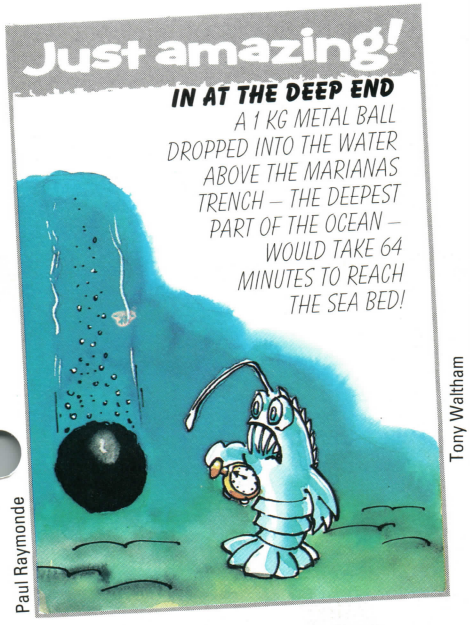
Equally unexplored are vast networks of natural underground passages, chambers and tunnels. The world's deepest cave – *Réseau Jean Bernard* in France – reaches

***Quicksand** is caused by water under pressure, forcing its way through river banks and percolating upwards through sand. This forces the grains apart, creating the suction that has pulled many explorers and animals to a lingering and gruesome death.*

Tony Waltham

***Geothermal** pools, such as this one in Yellowstone Park, are circled by brilliantly coloured minerals brought to the surface by pressurized boiling water.*

***Spluttering mud pots** are formed when hot springs, containing acidic, volcanic gases, break down minerals from the rock on their way to the earth's surface.*

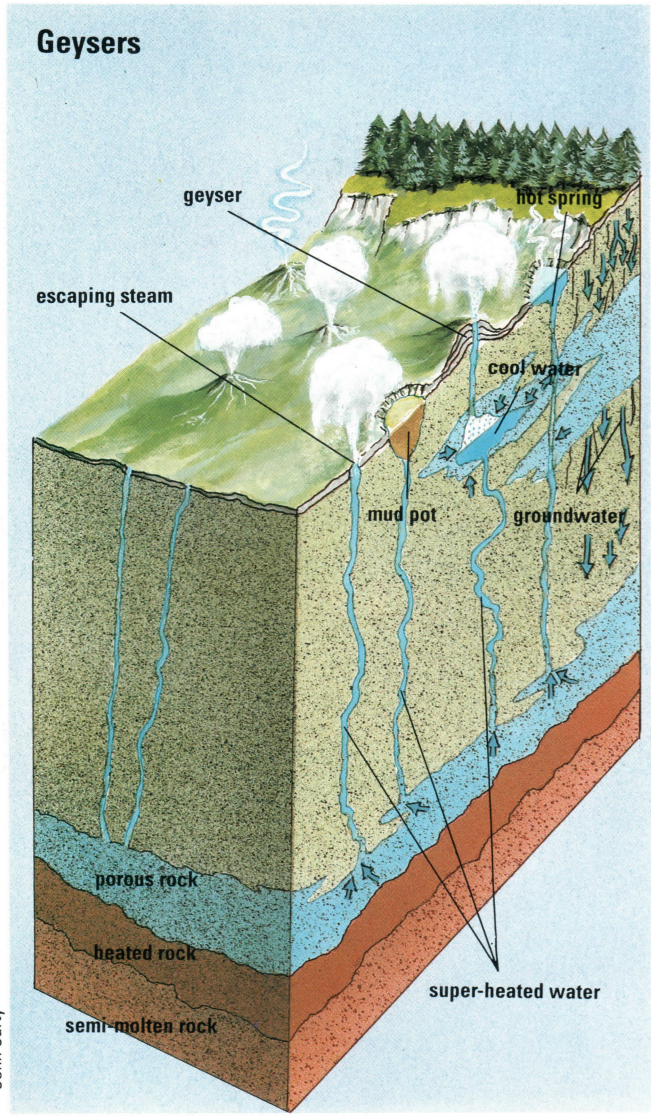


Paul Raymonde

Jungle fever

Jungles are difficult to explore, even with jeeps. Tree roots run across the forest floor, making it rough and uneven. Tree trunks and saplings are often too close together for a vehicle to get through. Finally, rain falls in heavy storms, turning dry land into a mudbath in just a few minutes.

Travelling on foot is easier but is fraught with danger from creatures that inhabit jungles. Explorers have to contend with blood-sucking leeches that attach themselves to the skin. Poisonous snakes and spiders rest on tree brances or lurk in damp places, attacking anyone that dis-



John Carty

Tony Waltham

***Geysers** are formed by superheated water rising into pockets of groundwater. A small amount of water reaches boiling point and the resultant steam rises to the surface, taking some of the water with it .*

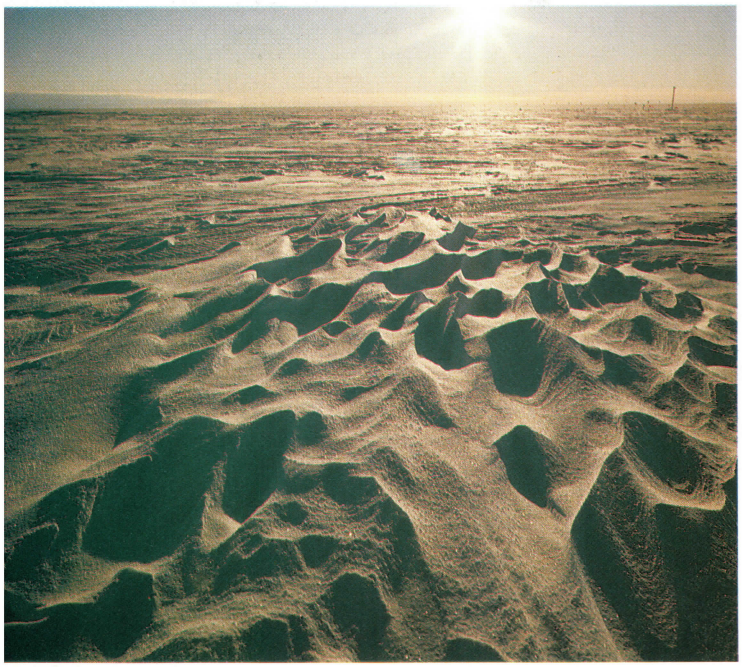
turbs them. Insects carry micro-organisms which, if introduced into the body, cause serious diseases such as sleeping sickness and malaria.

Harsh climate is the reason why the Arctic and Antarctic still remain largely unconquered. These are vast areas of permanent ice, snow and cold waters. Even in summer the temperature rises to only about 8°C above freezing and can fall to -50°C Frostbite is a constant danger.

Loose snow, crevices, glaciers and steep slopes make journeys across these frozen wastes very difficult. Sledges or caterpillar-track vehicles must be used. Food and fuel have to be transported, hampering progress. For prolonged stays or treks, permanent camps must be established and provisions brought in by boat or plane.

Icy wastes

The Arctic is an area of frozen ocean surrounded by large masses of land. Waters around the ice-cap freeze in winter, then thaw in the spring. It is impossible to predict when and where the ice will break up, so one cannot make any fixed settlements on the edge of the ice cap. The Antarctic is a mass of land permanently buried beneath a great sheet of ice. Here, countries such as Australia, Norway, Britain and Chile have established settlements. But people usually spend only a few months there at a time.



Geoff Renner/Robert Harding Picture Library

***The Antarctic ice sheet** comprises nine-tenths of the world's supply of fresh water. Since its discovery in 1820, explorers have battled against sub-zero temperatures, raging snowstorms and icy crevices to chart Antarctica's frozen wastes. Covering an area about 14,245,000 sq km, the frozen continent is larger than any country in the world except Russia. The average temperature in one area is -57°C. Winds can reach 300 km/h.*

THE AMAZON

The Amazon – 6,500 km long – is the world's second longest river after the Nile. It cuts through some of the most inhospitable and inaccessible territory on Earth. On its long journey to the sea, the Amazon varies in colour. High in the Andes, near its source, heavy loads of mud and silt make the water black. In contrast, some of its tributaries have crystal-clear water and are called the white rivers – rios blancos. Both white and black streams flow side by side for several miles in separate currents at Manaus, where the Rio Negro flows into the muddy Amazon.

COURSE GRADIENTS

SLALOM SKILLS

ELECTRONIC TIMERS

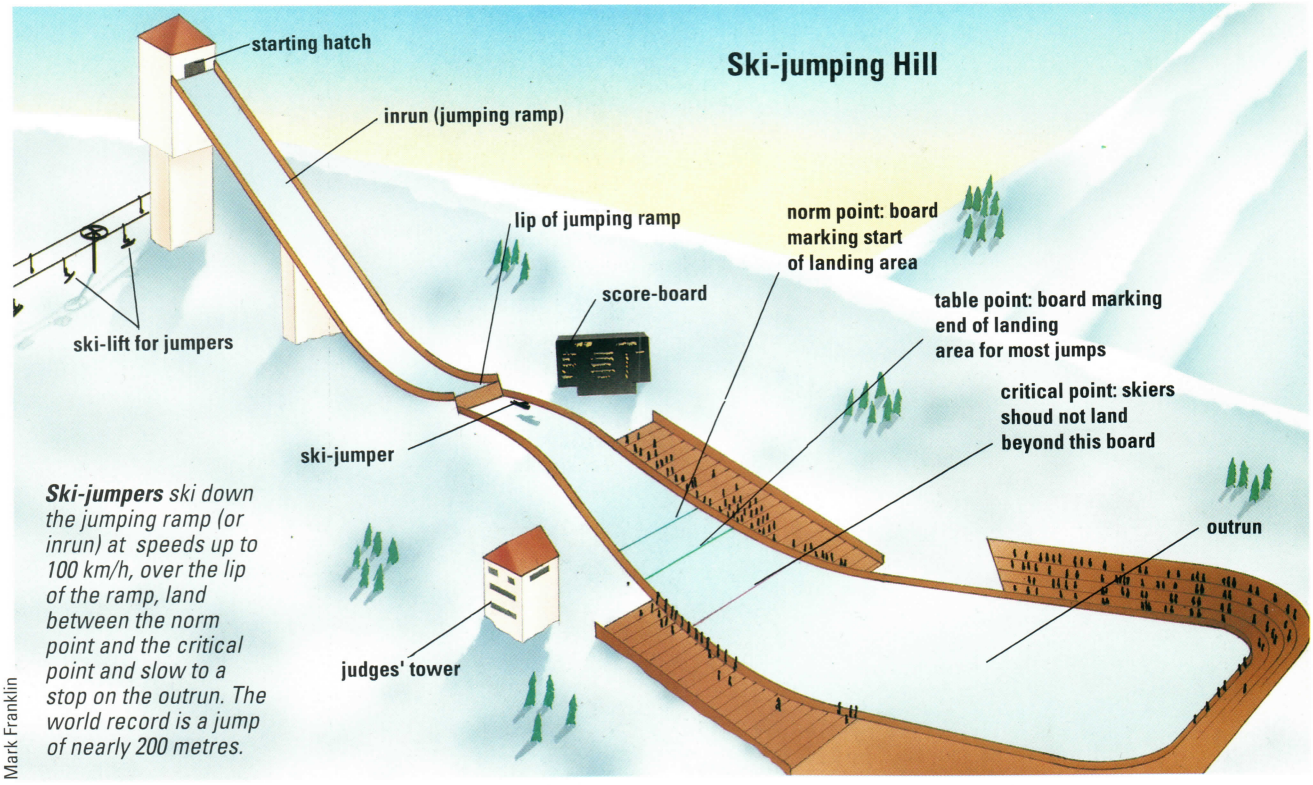
SPEED ON SNOW

THE FASTEST SPEEDS MAN can achieve on land without mechanical help are on snow and ice. Skiing is one obvious example, with some downhill skiers reaching close to 200 km/h. But there are many other types of winter sport that are every bit as thrill-packed and dangerous, such as ski-jumping, bobsleighing and tobogganning.

Competitive skiing can be divided into two main types of event: Alpine and Nordic. Alpine skiing includes slalom and downhill racing, while ski-jumping and cross-country racing are

***A downhill racer's** gear – from crash helmet to ski poles that fit around the body – reduces wind resistance to a minimum.*

L Dardelet/Explorer

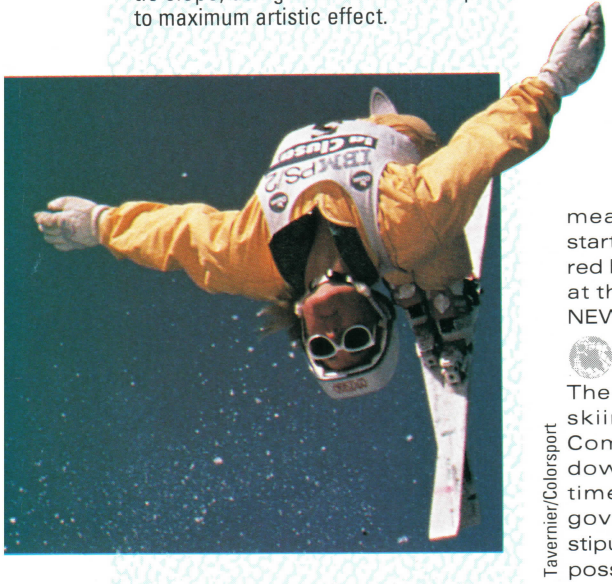


***Ski-jumpers** ski down the jumping ramp (or inrun) at speeds up to 100 km/h, over the lip of the ramp, land between the norm point and the critical point and slow to a stop on the outrun. The world record is a jump of nearly 200 metres.*

Mark Franklin

ACROBATICS ON SKIS

Freestyle skiing has become more and more popular in recent years – a reaction to the strictly stylized moves required in conventional skiing competions. At *aerial* events, skiers perform upright jumps and single, double and even triple front and back somersaults. *Mogul* skiers jump and turn to music as they ski down a special – very steep – slope. *Freestyle ballet* is slightly easier. Competitors 'dance' to music on a gentle slope, using their skis and ski poles to maximum artistic effect.



Tavernier/Colorsport

classed as Nordic events.

In slalom races, the skier has to follow a downhill course while weaving in and out of 'gates' – usually marked by flags. The gates can be 'open', that is, positioned across the hill, or 'closed', which means the line of the gate follows the line of the fall.

The skill of slalom skiing is to complete the course in the fastest time, without missing any of the gates, although hitting or knocking out a pole is allowed as long as the skier passes through the gate. Because the turns are so tight, the maximum speed of a skier in a slalom race will only be around 40 km/h. Giant and supergiant slalom runs are much faster, because the courses have larger drops and more widely spaced gates. In all forms of Alpine skiing, times are measured electronically. The timer starts when the skier breaks an infrared beam or mechanical starting gate at the beginning of the course (see NEW TECHNOLOGY pages 183-4).

Against the clock

The other main type of Alpine skiing is downhill racing. Competitors race straight down a course in as fast a time as possible. FIS – the governing body of skiing – stipulates that it must not be possible to complete the men's run in less than 2 minutes, and the women's in less than 100 seconds. Scattered pine needles mark any dangerous bumps and dips. To keep air drag down, a downhill racer tucks his or her body into an 'egg position' with elbows touching bent knees. At top speed, skiers can reach 140 km/h. Skis used for downhill racing are heavy, long and wide. Smaller skis, more suitable for turning and twisting, are worn in slalom events.

Even faster than downhill racing is a speed trial known as the 'flying kilometre'. The short course slopes at an angle of 45° for most of its length. A skier, timed over the last 100 metres, may reach speeds of over 200 km/h. The problem then is to stop safely, so

***Speed skater** Bonnie Blair from the USA. The blade on a speed skate is reinforced with steel tubing to strengthen it.*

Bob Martin/Allsport

Sipa Sport/Colorsport

the slope flattens out and runs uphill slightly for at least 300 metres. But the skier may still be flung off balance as his skis slow down.

At the other extreme, Nordic cross-country skiing courses can be as long as 50 km (15-50 km for men; and 5-20 km for women). Courses are flatter than in Alpine racing and require stamina rather than speed – skiers have to ski uphill as well as down.

***A luge run** finishes at the 1988 Calgary Winter Olympics, where the ice-covered, refrigerated track is over 1,000 metres long.*

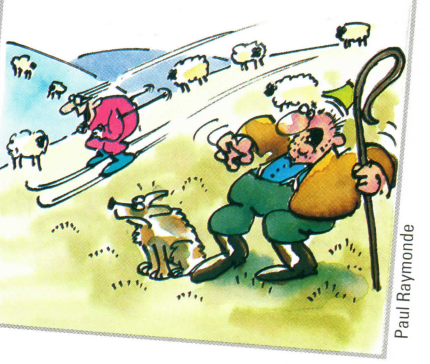
***A bobsleigh team,** (driver, brakeman and two extra riders) push-starts the bob together. Once under way, bobsleighs reach speeds of 150 km/h.*

Vandystadt/Allsport

Just amazing!

WELL OFF-PISTE

SNOW IS NOT THE ONLY NATURAL SURFACE FOR SKIING. GRASS SKIING HAS ITS OWN WORLD CHAMPIONSHIP, WITH A RECORD SPEED OF NEARLY 87 KM/H.



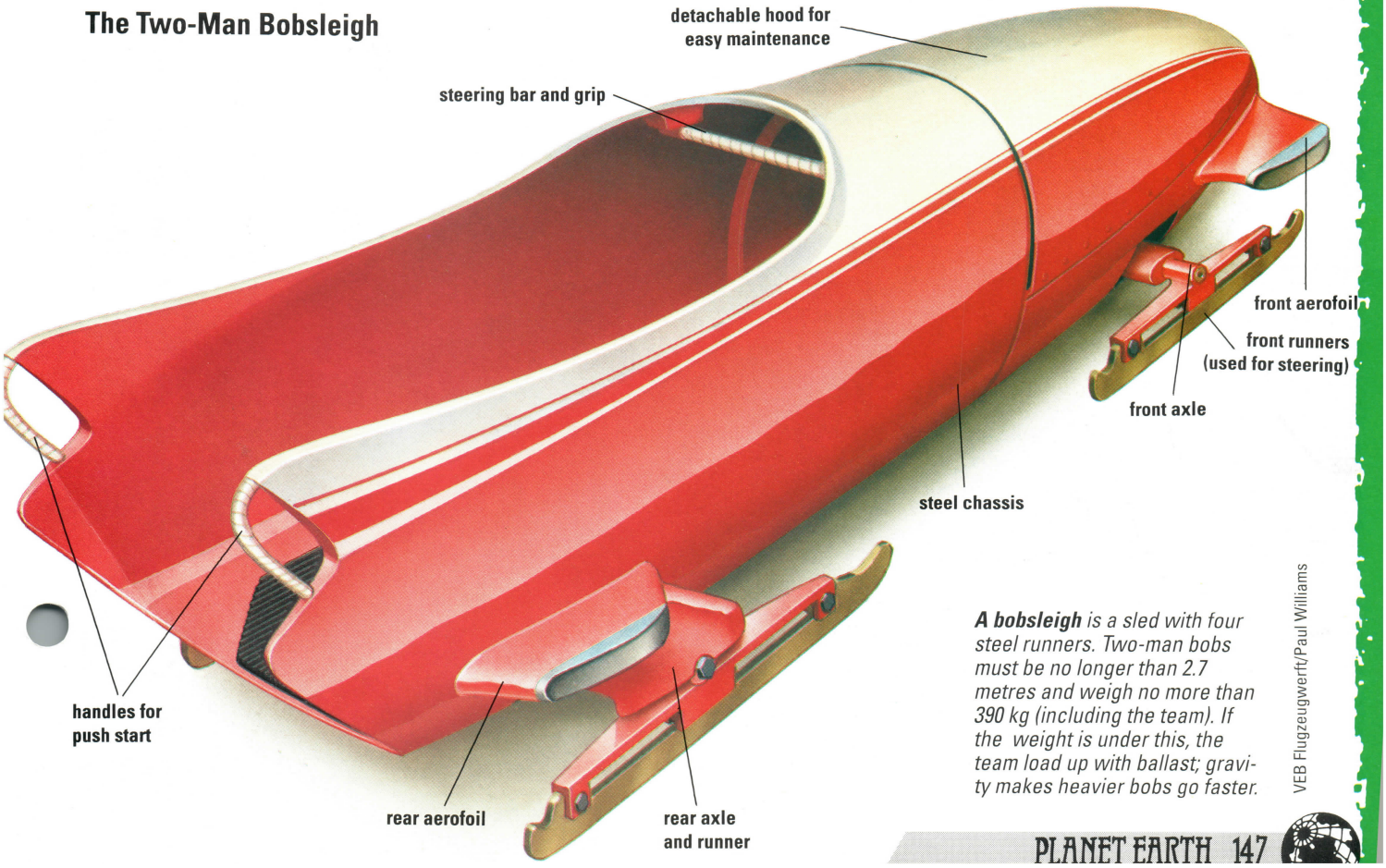
Paul Raymonde

Ski-jumping is spectacular and very dangerous. A skier hurtles down the jumping ramp of a specially-constructed jumping hill, from which he takes off into the air at speeds of around 100 km/h. He travels at least 100 metres in the air before landing – the world record for the total jump is nearly 200 metres.

Over the edge

Judges sitting in an observation tower give points for the distance covered before landing and for style. If a skier touches the snow or his skis with his hands (no ski poles are allowed) during takeoff, flight or

The Two-Man Bobsleigh



***A bobsleigh** is a sled with four steel runners. Two-man bobs must be no longer than 2.7 metres and weigh no more than 390 kg (including the team). If the weight is under this, the team load up with ballast; gravity makes heavier bobs go faster.*

VEB Flugzeugwerft/Paul Williams

NEW WAVE SKIING

Bored with racing and jumping, skiers have combined skills from different sports to create new activities. *Snowboarding* is a little like skiing on a skateboard. The snowboarder stands on the 'deck' of the snowboard just like a surfer, except that the feet are secured with fixed bindings. *Parapente* is paragliding on skis. An enthusiast skis over the edge of a precipice and glides down to the valley floor with the help of a parafoil (a cross between a kite and a parachute). The parafoil is then packed into a bag and taken up in the lift for the next time. The toughest of the new disciplines must be *ski extreme*, a cross between mountaineering and skiing. Ski extreme enthusiasts aim to make first descents rather than first ascents, climbing a peak on foot (or using a helicopter), then skiing down the rocky mountainside.

landing, it is considered a fall and he may only score 0-10 points. A skier who does not fall may score between 6 and a maximum 20 points.

High-speed sleds

The bobsleigh was invented by a group of Englishmen in Switzerland in 1890, when they added runners to their toboggans (sleds) to make them go faster. Teams of two or four men try to get their bobsleigh down the course in the fastest time. The bob starts about 15 metres before the start line. The team may push the bob as far as they like before jumping in; timing starts as soon as the front of the bob crosses the starting line.

All races are held on specially built runs with steep curves, made of packed ice. Courses must be at least 1,200 metres long with a gradient of 8-15 per cent and must have at least 15 banked curves, which can be up to 6 metres high. The top of each curve is concave to keep the bob on the course. Some courses have concrete foundations, on which snow and ice form in freezing weather. Electrical equipment is often used to keep critical points of the run frozen during warmer weather spells.

Another of the toboggan's modern descendants is the luge (French for toboggan), on which one or two riders lie on their backs and travel feet-first. Riders can only steer by pulling on reins attached to the runners, squeezing the runners with their legs and by shifting their weight. No other forms of steering are allowed, even though the luge may reach speeds of up to 125 km/h.

***An ice speedway** track must be at least 10 cm thick. An ultrasonic pulse is sent through the ice and the time taken for it to return indicates the depth of the ice.*

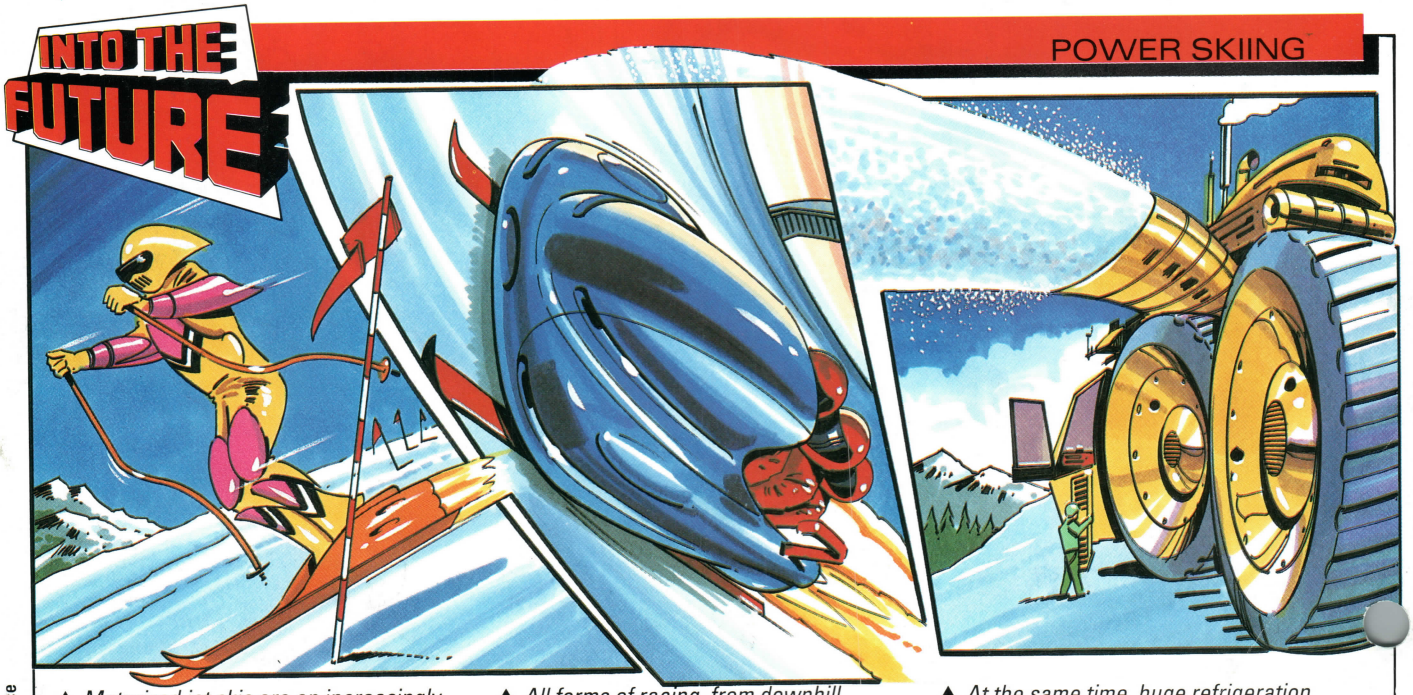
Chris Cole/Split Second

***The biathlon** combines skiing and cross-country shooting. After each circuit of the 4 km course, the skier fires 5 rounds with a 4.5 kg rifle at targets that are set 50 metres away.*

Sporting Pictures

INTO THE FUTURE

POWER SKIING



Joe Lawrence

▲ *Motorized jet skis are an increasingly popular way of travelling around ski slopes, and may one day feature in downhill or slalom racing.*

▲ *All forms of racing, from downhill skiing to bobsleighing, could benefit from rocket propulsion, leading to even faster and more spectacular events.*

▲ *At the same time, huge refrigeration units and more sophisticated artificial snow machines will keep skiing conditions perfect all year round.*